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FAO — The Food and Agriculture Organization of the United Nations — grew out of a United Nations Conference held at Hot Springs, Virginia, U.S.A., in May 1943. The nations agreed to work together to secure a lasting peace through freedom from want. The Organization was formally founded at Quebec, Canada, in October 1945. It was located at Washington D.C. until 1951 when the Headquarters office was moved to Rome.

Unasylva is prepared by the Forestry and Forest Products Division, directed by Mr. Egon Glesinger and published every quarter in English, French and Spanish. It attempts to cover a range of interest as wide as that of the Forestry Division whose work it mirrors. Signed articles express the opinions of the authors and do not necessarily represent the views of the Organization. All material in ***Unasylva*** may be freely reprinted, but acknowledgment is requested, together with a copy of the publication containing the reprint.

Cover Photograph. *Timber operations in the tropical forests of West Africa. Every log is given an identification number before being evacuated to the river. This enables its progress to be recorded up to the time of its conversion in the mills or its export overseas as a log.*

Courtesy, United Africa Company Limited

Unasylva

An International Review of Forestry and Forest Products

MARCEL LELOUP

MARCEL Leloup has retired from FAO, at a time when his energy and intellect are as keen as when he was first called to direct the Forestry and Forest Products Division twelve years ago. But Leloup is a man of principles. He is also a true Breton and, therefore, obstinate. He has always maintained that the old must in good time make way for a younger generation. He had already been persuaded to prolong his term of office longer than he intended: now he has decided that his limit has been reached.

Insistence on principles is undoubtedly Leloup's most characteristic trait and is at the root of his success in life. It has certainly given a personality all its own to the Forestry and Forest Products Division of FAO which he created, and a distinctive cast to the policy which that Division has pursued. His principles have underlain the wide range of activities undertaken by the Division, and his stand on the regional approach has allowed world-wide coverage to be achieved despite the complexity of the divisional program. If FAO has been able to claim some success in its work for world forestry, it is to Marcel Leloup first that must be ascribed the credit.

Leloup is able to carry through great ideas because he does not allow himself to become enmeshed in details. Having given directives, he leaves the fulfilment of his plans to colleagues whom he has himself selected and to whom he confidently delegates responsibility. However, in so doing, he never hesitates to make himself answerable for the ideas which he is convinced should be given substance. This is a measure of the qualities of the man who was seriously maimed in war, became a forester and then turned to world affairs.

It is inevitable that a man so forthright should meet with opposition. Nevertheless, he often wins his case because he has a sure judgment of the arguments to be employed and an accurate sense of timing. He also knows the limits of the strength of his position. Beyond that, being blunt but honest, strict but essentially fair, sometimes angry but with a lurking smile, he wins friends and admirers even among those who cannot subscribe to his views.

Leaving FAO, Leloup fully realizes that many of his goals have yet to be attained. He is sometimes still impatient at this and perhaps a trifle disillusioned. He retires, however, with the satisfaction of being able to say that he has not surrendered any of his battles through compromising on principles.

He leaves behind him a team of colleagues whom he has trained to carry on his work and reach towards his goals. And the Forestry and Forest Products Division will continue to seek advice and inspiration from this great personality who, though relaxing in retirement, will still remain its spiritual head.

FIGURE 1. – *Experienced African axemen, balancing on flimsy structures of saplings which raise them above gigantic buttresses, skilfully fell the trees of the African forest. (A shot from the Unilever film "The Twilight Forest".)*

Courtesy, United Africa Company Limited for all photographs in this article

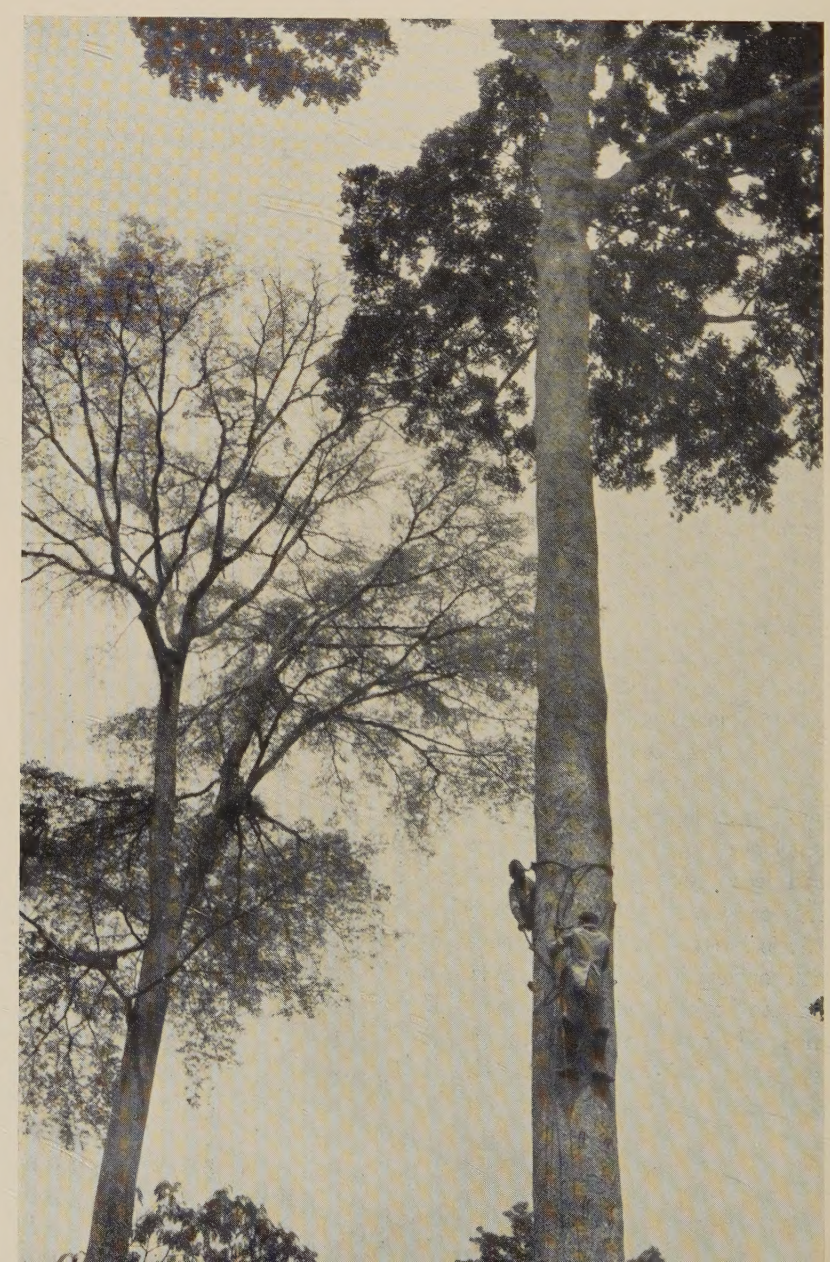

FIGURE 2. – *High above the forest, two Africans fix a wire rope block to a tall tree, which is used as a mast from which logs are hauled and loaded on to waiting transport.*

Timber Operations in West Africa

D. H. Buckle.
Manager, Information Department, United Africa Company, London

It is probable that among the many problems which timber companies throughout the world have to face, nowhere are they more arduous than those encountered by the companies operating in the tropical rain forests of West Africa. The film "The Twilight Forest", produced by Unilever, tells part of the story of the operations of its subsidiary, The United Africa Company (Timber) Limited, and associated companies, African Timber and Plywood (Nigeria) Limited and African Timber and Plywood (Ghana) Limited, in these forests. In this article the forestry operations outlined in the film are elaborated and the processes of converting the timber into a marketable form are described.

The West African forest belt extends over an area of 150,000 square miles, (388,500 square kilometers), varying in depth from 50 to 150 miles (80 to 240 kilometers) from the coast.

In Nigeria, of its total area of 373,000 square miles (966,000 square kilometers), about 139,000 square miles (360,000 square kilometers) are forest lands. However, it is the Western Region which contains the important timber bearing areas of Nigeria: there is no extraction for export in the Northern and little in the Eastern Provinces of Nigeria. The total area of the Western Provinces is 44,000 square miles (114,000 square kilometers), of which 18,529 square miles (48,000 square kilometers), or 42 percent is forest land, over one half of this area — 10,571 square miles (27,400 square kilometers) — is closed forest, which means the trees grow so close together, there is a continuous closed canopy of foliage. Forest reserves account for 3,863 square miles (10,000 square kilometers) of this area, while 6,708 square miles (17,375 square kilometers) are unreserved.

The reserved forest does not consist of a single block of land, but of a large number of isolated irregularly shaped islands of reserve scattered over the whole closed forest area.

In Ghana, 30,000 square miles (77,700 square kilometers), or one third of the country, comprise the closed forest zone. One half of this area has been converted to farm land and of the 17,000 square miles (44,000 square kilometers) of forest remaining, about 6,000 square miles (15,500 square kilometers) have been declared reserve forest, the remaining 11,000 square miles (28,500 square kilometers), being unreserved. This latter area will eventually be converted to farm land, while the remaining 6,000 square miles (15,500 square kilometers) will be conserved in perpetuity.

In the forests of West Africa many different species grow side by side. Nowhere can the operator be certain that one area will produce a good stand of timber and that another can be ignored completely as unproductive, either in quantity or in the quality of wood available.

Of the three types of forest in West Africa — swamp, savanna and closed — only in the latter does the stand of timber repay commercial extraction on a large scale. Here, the West African timber trees acquire their valuable characteristic — long, clean boles, the first branches being often over 100 feet (30 meters) from the ground. In the main, where there are two annual peaks of rainfall, the forest is evergreen. Where there is a single pronounced annual peak followed by a relatively dry season (i.e., in the monsoon climate) the forest is deciduous and loses its leaves in the summer.

The forests of West Africa are not so difficult to penetrate as the jungles of Malaya, and in some districts it is possible to walk through the forest with comparative ease. There is, however, a great diversity of forest trees and secondary growth of varying ages, and giant trees rarely occur as clumps or groups of a single type. The timber man has, therefore, to search carefully for trees of the right species and maturity.

Nearly half the forest leased to the United Africa Company is open forest where Africans settle and farm. The traditional way of clearing the land is by burning, and much valuable timber is constantly lost in this way. If, in the opinion of the Forestry Department, it is fairly certain that the timber trees in any particular area will be destroyed in the near future, whether for farming operations, urban expansion or road development, then the Forestry Department may designate the area for salvage felling, and the concessionaires may exploit the area fully, i.e., they may extract all the timber without restriction and without regard for the regeneration of the forest. This is a true salvage operation, and but for it timber in such areas would be burned or felled and allowed to rot.

The rest of the Company's forest areas are reserve forest where fellings are carried out in accordance with the plans of the Forestry Department. These plans treat timber as a crop and are expressly designed not only

to avoid denuding the forest — but also, indeed, to preserve it for ever. An area once worked is closed until the forest has again grown, which may take as long as a hundred years. Meanwhile, the Forestry Department select and protect young seedlings, poison useless trees, keep weeds down and do everything possible to stimulate the regeneration. In due course the area should be even more abundant than it was at the time of the original felling.

Each concession is divided into mile squares, and the Company has to nominate the squares that it will go into and work over a five-year period. Once that has been done others may not be entered nor may they be re-entered once the time for completion of extraction as laid down by the local authority has elapsed.

Historical Background

The tradition of felling timber in West Africa has been inherited by the present companies. Up to the late nineteenth century no export timber industry existed in Nigeria and the great natural forest resources remained untapped.

About 1890, enterprising pioneers such as Crauston, McNeil and Mathieson began operating in the Benin Province, making Sapele the first port to export timber from Nigeria. The firms first in the field were McIvers, McNeill Scott, and Miller Brothers. The last named, a famous West African trading firm, began their timber enterprise at Koko on the Benin river in 1917.

In these early days the sole export was logs of which only a few species were shipped, such as Sapele wood, Lagos wood (Lagos mahogany), sida wood (African walnut) and iroko.

With the formation of the United Africa Company in 1929 by the amalgamation of the Niger Company and the African and Eastern Trade Corporation the timber interests came under unified management, which is today the United Africa Company (Timber) Limited.

Species

The most popular timbers extracted today are: walnut, mahogany, obeche, agba, niangon, iroko, sapele, guarea, opepe, makore, edinam and idigbo. Although the Timber Development Association Limited have published a booklet, *Timbers of West Africa*, which gives full details of the characteristics and uses of 72 different species of West African timber, all of which are of some commercial value, the Company today extracts in all only 20 species.

During the war years and after, an opportunity was given of popularizing a greater number of intrinsically valuable West African timbers, and at one time the United Africa Company was extracting 40 different merchantable species. Constant and persistent efforts are continually made to investigate and introduce a greater variety of species into the commercial list, as only by this means can the true wealth of these forests be utilized.

Establishment of Timber Operations

First considerations

The problems encountered in the setting-up of timber operations in West Africa are complex in that not only have the vagaries of climate, terrain, soil conditions, etc., to be considered, but also the varying traditions and usages of the people on whose lands operations will be conducted.

There is much to do before a timber industry can be founded in a primitive environment. Someone must explore the forest and decide whether there are sufficient merchantable trees, and whether the costly process of opening it up for logging operations would be repaid by the timber obtained.

The first step before exploration is to acquire from the owners an option to inspect and survey the forest and to apply for a concession. This secures for the Company the right of first refusal from the owners of the land.

The trees in the forests of Nigeria and Ghana are the property of the African communities who own the land on which they stand. Procedures for obtaining concessions vary from territory to territory, but in three important respects they are similar: the procedure is laid down by law. The interests of the lessor, who in some cases may be illiterate, are fully protected; the lessee obtains some assurance that the concessionary rights are valid in law for the full period named in the concession.

Sample enumeration

When an option has been obtained, a sample appraisal of the timber in the area is undertaken.

A series of strip enumerations is taken at regular intervals throughout the forest; the area of the strips usually totaling 1.25 percent or one eightieth part of the forest area. In the course of this survey every tree of marketable size within the strips is recorded, by species and by size groups, with special attention to topographical features which may affect extraction and transport.

This gives a rough idea of the commercial possibilities of the area and it is on this that the Company decides whether or not to apply for a concession.

Once the Company has decided that a certain area of forest presents good commercial opportunities it will apply for a concession which, if the area is large, will usually be a long-term one.

Concessions

It is appreciated that security of raw materials over a considerable period is an essential prerequisite before the heavy costs of investment in modern plant and buildings can be incurred without undue risk. There are three interested parties involved in the concession;

FIGURE 3. – *The photograph shows logs being loaded on to large diesel lorries capable of carrying loads of up to 25 tons.*

the owners of the land, the Forestry Department, and the Company. Once these parties have come to terms the lease is signed and passes on, according to the regulations in force in the area, to receive legal or official recognition.

The concessions are usually for 25 or 50 years. They are drawn up on the basis of an agreed sum being paid to the owners for each tree felled, or for each cubic foot of logs extracted. Sometimes, these "royalties" or "felling fees" are combined with a ground rent for the concession, or a guarantee of a minimum annual payment per acre or square mile.

Complete enumeration

The next step to be taken before the commencement of logging operations is the full enumeration of those sectors of the Company's concessions in which extraction will begin. This involves taking a census of the entire population of merchantable trees and many likely secondary species as well. The selected area is, as already mentioned, subdivided into one-mile squares, the boundaries of which are marked by cutting walkable traces. These squares are further divided by walkable traces into eight equal rectangular divisions.

A team of 25 men, led by an experienced forest surveyor, then advances along the length of each division, each man being approximately 20 yards (18 meters) from his neighbor. On spotting a tree of a selected species he calls out, the line stops, the tree is measured and classified by the enumeration clerks, and if its girth is over a certain minimum it is recorded in the field books. Each tree is also marked with a number for subsequent identification. At the same time topographical readings are taken enabling a contoured map to be produced later. Two such teams generally progress at a rate of at least 30 square miles (77 square kilometers) each year.

This painstaking technique enables the forest manager to keep accurate records and to arrange his extraction program to conform with fluctuations in market demand.

The results obtained from the survey are continuously compared with the exploitation results forecast by the planning and progress departments at headquarters in order to correct and improve upon the production estimates by applying more accurate trees/volume of logs conversion rates. This action is taken because of the necessity for accuracy in the forward estimates.

Administration of Forest Areas

Each of the main concession areas is independently managed and self-sufficient, while working to the forest extraction program directed from headquarters. The head of the concession operating is the forest manager who is in charge of planning and administration. On his staff he has a production supervisor and a forest assistant and they share the duties on the ground — which include preparing the loading sites, planning ahead, making roads, supervising the felling gangs, haulage, loading at the sites and despatch to the mills; two plant supervisors share the duties of repairs and overhauls of all vehicles and forest plant.

Each concession is linked by radio with headquarters three times a day for progress reports and planning arrangements.

Method of felling

Most of the West African species grow with the root structure forming buttresses above ground level. These buttresses are often of gigantic dimensions and the usefulness of the tree begins above the buttress. This characteristic necessitates felling at 10 or 15 feet (3 or 4.5 meters) above ground level, for which reason and because many of the trees are of enormous girth, mechanical sawing is impracticable and all trees are felled by axe. Fantastic though the method may appear in this age of mechanization, the skill and speed of felling by experienced African axemen, balanced on a flimsy structure of saplings built round the buttresses, has proved to be the best method.

Mechanized extraction operations

Before extraction can begin, roads must be built so that, when felling is started, it is properly co-ordinated with transport to evacuate the timber. The keynote of extraction is smooth and economic operation of transport in which connection crawler tractors and graders, diesel-engined loading winches and lorries have wholly replaced manual labor formerly engaged in huge teams to do this heavy work. One important consequence of the remarkable increase in mechanization is the way in which the entire operation of timber extraction has been accelerated, with the result that there is little time for the wood to deteriorate, or suffer damage from insect attack or fungus, as often happened in the past, and considerable economies are effected.

When a tree has been felled, the branches and leaves are removed at the stump, and the trunk is dragged along the forest " traces " to the loading point on the nearest extraction road. For this operation a crawler tractor is employed in conjunction with a " logging arch " which enables the leading end of the log to be carried clear of the ground with only the heel dragging on the ground. When the log reaches the vehicle loading point the bark is removed and the tree is cut into lengths, suitable for loading on a road vehicle, by powerful electric chain saws which save time, labor and money, and receives its initial treatment by being sprayed with powerful insecticides and fungicides.

At the loading point, the logging assistant makes the first definite classification of the logs. He divides them into the logs required for the plywood mill, for the sawmill and for export. Each log is then given an identification number — a number which accompanies it until final utilization. The numbers are scored on the sides and ends of the logs. The standard method of lifting logs, which may weigh 10 tons or more, onto vehicles is to make a temporary clearing in the forest adjacent to a standing tree selected for its suitability as a mast. An African, possessing the natural skill of climbing tall trees with the aid of a hoop of vine and climbing irons, ascends the tree to fix a wire rope block 100 feet (30 meters) or more above the ground through which a heavy wire rope is passed. In principle, one end of the rope is attached to a log awaiting transport and the other end to a powerful diesel engined winch. With this simple tackle individual logs can readily be swung high over the top of other logs and be gently placed on a waiting vehicle.

Various types of logging vehicles are used according to the nature and length of the roads to be traversed and the load to be carried. In Nigeria, long distance log transport takes place by water. The logs are taken by the Company's large diesel lorries, capable of carrying loads up to 25 tons, to the nearest waterside installation and there off-loaded from the vehicles by crane. When sufficient are collected in the water, a raft is made, of floating pieces. The rafts used to drift on the current down to the Company's mills at Sapele, taking up to five weeks. Now they are towed by 150 h.p. diesel-engined tugs and rarely take longer than one week. This not only saves time but also avoids the loss of logs on the journey. As each raft arrives at Sapele its contents are checked and the logs are divided according to the up-country classification and towed to different storage pens in the waterways. Species heavier than water are generally carried by strings of barges and have, of necessity, to be stored on land. The best logs are generally destined as such for export and the remainder are segregated partly for the plymill and partly for the sawmill.

Logs for export may be round as grown, or " squared " by sawing, according to the requirements of the buyet. Most species are treated chemically to guard against insect damage. All log exports are made up into shipments in fulfilment of firm orders to definite specifications. These logs are loaded into ocean-going ships which come up the river to Sapele, 70 miles (112 kilometers) inland from the coast.

The loading operation is a complex one and the ships which can anchor alongside the Sapele mill are worked by experienced Kroo boys under the charge of a Nigerian foreman, supervised by a European officer. Once firmly stowed away, these logs are on the first lap of their voyage to the United Kingdom or elsewhere, as part of Nigeria's timber exports.

In Ghana there are no rivers which can be used for the transport of logs down to the mills and to the port. Consequently, haulage in the forest from tree stumps to mill over hilly broken ground is very different from that around Sapele. The entire haulage, from the mill to the port, of logs and lumber is done by road and rail.

Maintenance of forest plant and equipment

A workshop and a spare parts store are provided for maintenance in each forest concession, but for highly specialized work the plant or vehicle is taken to the main workshops or the Company's headquarters.

This system of forest workshops has the following advantages: it encourages the individual forest manager to take full responsibility; it gives him all the means for effecting running repairs and in some instances complete overhaul of the plant equipment under his control; it facilitates team work in the forest; and it obviates

the unnecessary movement of the vehicles and heavy plant.

The vast network of roads, with associated culverts and bridges, which have to be constructed by the Company through the jungle have, of necessity, an earth surface. The rainfall may average 100 inches (2,540 millimeters) per year which, together with tropical sunshine, often results in operations being carried out either in deep mud and water, or in thick abrasive dust. These appalling conditions treat the vehicles and plant in a most brutal manner and, in consequence, maintenance of the capital assets is heavy and their life short. It is greatly to the credit of all who work in the forest areas that they achieve so much under such adverse conditions.

Mill Operations

Siting of the mills

The problems of tropical timber extraction throughout the world follow a pattern. It is one of bringing valuable hardwoods to the city dwellers who prize them most. Consequently, it is primarily an export industry using ships. Bringing logs to the ships led to sawmills being sited at the ports in order to process export lumber from the lower grades of logs, the higher grades being exported as round (or squared) logs.

The siting of the industrial installations of the Nigerian Company at Sapele followed precisely this tradition. Because of the early work with the old sawmill at Koko — mentioned earlier in this article — there were grounds for hope that Nigerian sawn timber would find a ready market; and it was decided in 1935 to erect a sawmill at Sapele.

Sapele is at the confluence of three rivers — the Benin, the Jameson, and the Ethiope — actually on the latter river 70 miles (112 kilometers) up from the sea, at the highest point that ocean-going ships can reach. It has long been a timber port by virtue of its access through a network ofwaterways to the best forests of the country.

In 1948-50, the sawmill was rebuilt and re-equipped with modern machinery and mechanical handling devices. At the same time, a large plywood factory, the first in West Africa, was added.

The full importance of Sapele's position on the river is realized when it comes to the transport of logs from the outlying forest areas to the sawmill; sometimes the logs have to be brought a distance of 100 miles (160 kilometers) and more by river.

Before that there is a road haul, again for distances as great as 70 miles (112 kilometers). Normally, heavy diesel driven logging vehicles deliver the logs to waterside loading points, equipped with cranes, on the creeks or rivers of Southern Nigeria. A network of hundreds of miles of roads has been built throughout the forest areas by the Company, for there were few other roads through the forest. (In other lands the problem is not so acute for roads do exist through the forests between towns and cities, but in West Africa spur roads, secondary access roads and main extraction roads all had to be constructed; where streams could not be forded, bridges had to be built, and all roads lead to the great natural highway of the river).

In the forests surrounding Sapele there are three main areas of concessions. One is in the Ife-Ondo region — 100 miles (160 kilometers) from Sapele by waterway. Most of the logs are floated to Sapele from here by rafts.

Another area is at Nikrowa, 50 miles (80 kilometers) by road from Sapele across two ferries and then 60 miles (96 kilometers) by waterway.

The third forest area, at Sapoba, is only 15 miles (24 kilometers) from Sapele by road or by waterway.

These three areas are, for the most part, situated in "reserved forests" intended to form the country's permanent forest area.

On the other hand, the siting of the sawmill at Samreboi in Ghana in the middle of the forest and 150 miles (240 kilometers) inland, represents a logical departure from tradition. Takoradi, the nearest port of evacuation, is only accessible by rail or road, and the decision was made solely to save transport charges, which are minimised by carrying processed products instead of raw materials. This point is better appreciated when it is realized that about half the bole of a tree is wasted in cutting it into lumber.

The town of Samreboi was built entirely by the Company on a mile square cleared of dense jungle. The site was chosen in 1947 to enable the headquarters to be established roughly in the center of the concession and although there is a nearby river, the Tano, this is subject to seasonal fluctuations in level and renders it useless for log storage. Therefore, an artificial log pond has been created to provide log storage while logs are awaiting export or conversion in the mill. There were no public roads in the logging areas around Samreboi and the Company, therefore, had to build its own roads, not only in the forest areas but to and from the areas and to the railhead at Prestea, 43 miles (69 kilometers) to the south, which links with the ocean port of Takoradi.

When the sawmill, power house, workshops and European and African houses were first being built, all the construction material had to be sent from Takoradi to Insu by rail, then by the Enchi road — a public road — to a point north of Samreboi. From this point an "access" road, 14 miles (22 kilometers) long, had to be built to reach Samreboi, a distance of more than 150 miles (240 kilometers) in all from the port.

The original task of building these roads was carried out by members of the Company who walked the forest, often following hunters' tracks and forest paths from one village to another, and sometimes cutting paths through the bush where no man had been before. Many difficulties were encountered and overcome in the post-war days when bulldozers and other road construction equipment were in short supply and labor was not plentiful. It is difficult to make roads on soft soils which have little or no rock or stone base and at the best are composed of laterite or at the worst cleared tracks through swamps and clay.

FIGURE 4. – *The logs are carried into the sawmill from the river by a double-gantry. The squared logs in the picture are awaiting export.*

To keep such roads open to regular heavy traffic through the seasons requires experience and judgment, and today they are given constant maintenance by teams equipped with their own plant, huge bulldozers, tippers, roadrollers and ditch-diggers.

Capacity of the mills

The capacities of the mills in Nigeria and Ghana were based, fundamentally, on the expected annual yield of raw material from the concessions and together can handle over 9,000,000 cubic feet (255,000 cubic meters) per annum which by any standard is a large volume of timber. The undertakings are the largest industrial unit of any type in either country, being of capacities far greater than any other mills on the African continent and comparable only with mills in America.

Sawmilling processes

The timber enters the sawmill from the riverside or log pond and is carried by electrically operated traveling cranes to the headrigs.

Mechanical handling has been introduced in both mills, while forklift trucks and straddle carriers are used to move sawn timber and plywood to and from the storing sheds.

Inside the sawmill the logs pass through a number of different sawing stages, depending upon their quality, shape and size. This work calls for quick and sound judgment in deciding how the logs are to be sawn, and a high measure of skill in controlling the machines.

The ultimate aim of the sawmill operation is to obtain the longest possible pieces of high grade sawn wood from each individual log which enters the mill.

It is particularly noteworthy that all the operations and the complete handling in both mills are mechanical. Movement from one process to the next is accomplished on electrically driven rollers or by chain conveyers.

The headrig operation is the first stage of the conversion from the log into sawn timber. Two vertical log bandsaws having flexible saws of up to 14 inches (35.5 centimeters) wide and travelling at 8,000 feet (2,438 meters) per minute are operated in this part of the mill. The headrig sawyer is a highly skilled African.

To obtain the greatest benefit from the operations

the headrig must be operated at speed — no small task when the carriage, together with large log, may weigh over 10 tons and travel at speeds of up to 500 feet (152 meters) a minute in either direction on its track past the bandsaw. A small mistake or minor error of judgment may ruin the log being sawn, or even wreck or damage the saw.

Once the headrig operation has been completed, large planks of roughly sawn timber are then mechanically carried forward to the next operation. Here a band "re-saw", which is also a vertical bandsaw, takes some of the thicker material from the headrig and saws it into two, three and sometimes four thinner boards of the thickness required by the trade.

It is interesting to note that the use of this "re-saw" enables the final job of cutting comparatively thin planks to be done away from the headrig operation which, being of greater size, precludes fine sawing work. Consequently, a greater throughput is obtained at the headrigs.

Complementary to these machines is the frame or gang saw. This consists of a vertical reciprocating frame carrying a number of straight saws evenly spaced to produce the desired board thickness. "Flitches" up to 14 inches (35.5 centimeters) in depth and 40 inches (1 meter) wide, cut from the log of the headrig, are fed into one side of the gang saw by power rollers. Often as many as 32 boards at a time may be produced. It is interesting to note that the gang saw makes 240 strokes a minute and the saws make a cut of 0.5 inch (13 millimeters) at each stroke; it thus takes about one minute to produce 32 boards 14 inches (36 centimeters) wide and 10 feet (3 meters) long.

A fourth type of saw used in the sawmill is the circular saw, which is used for ripping — that is, sawing along the length of the timber — or for cross cutting — that is, sawing at right angles to the length. Ripping saws are used to square off the edges of boards and to remove knots and other defects by cutting along the side of them; while the cross-cut saws trim the ends of boards and scantlings, or remove defects.

Endless belts and pneumatic conveyors carry away sawdust and waste pieces of timber direct to the fuel bins of the power house, which generates steam and electricity for the whole of the enterprise.

In this business of obtaining the greatest possible wood yield from the sawn trunk and getting the highest returns, knowledge of the comparative values of long, narrow and short but broad material is called for in the edging and cross-cutting of timber passing through the mill.

The woods of Africa demand their own special treatment. The methods adopted vary widely and are dependent on the species, size, shape and quality of the log and on the "end-use" of the timber; for example, sawing a large Douglas softwood into the many sizes and grades of lumber used in the United States markets is very different from the conversion of a large African mahogany log into sawn timber of the sizes and qualities required by furniture makers or shipbuilders in the United Kingdom. The finished lumber does, in fact, find its destination in almost all countries of the world where it is used in an infinite number of ways.

The plymill

The Company decided that it could utilize its timber resources even more fully by constructing at Sapele a plywood factory. This was completed in 1950. Today, with floor space of 150,000 square feet (13,935 square meters), it is the largest building of its kind in West Africa. The aim was to set up a plywood mill which would produce a hardwood plywood of the highest quality by world standards.

This aim has been achieved, and the "Cresta" plywood produced is rotary-cut; that is to say, the log is rotated in a huge lathe when the log is peeled into a continuous length of veneer up to 9 feet (2.74 meters) wide, later to be made up into exterior-weatherproof, hardwood plywood, which is generally faced with mahogany, or Sapele wood, and is always made from an uneven number of plies. Though sometimes used in furniture manufacture in the United Kingdom and elsewhere, it is not regarded primarily as a decorative plywood, although by virtue of its character and quality it is so used on occasion. Its high exterior quality is much in demand for constructional purposes. It might be interesting to note that the adhesive used fulfils the most recent rigid requirements of the British Standards Institute, known as the 'WBP test' (weather and boil-proof bonded). The failing-load, i.e., the measure of strength of the glue, must not be, on the average, less than 200 pounds (91 kilograms).

It is not appropriate in an article of this kind to go into the details of plywood manufacture, which are complex and exacting, but it must be emphasized that in the African forest the variety of processes, from felling timber, choosing appropriate types of log, conditioning with steam, peeling the veneer, drying and cutting the sheets, coating with glue, and pressing and producing the final high quality plywood is all achieved by African skilled labor many thousands of miles away from the world's markets and industrial centers.

Management and maintenance of the mills

Apart from normal management skills required for the successful running of the commercial and technical sides of these large undertakings, wide knowledge of the African mentality, of wood technology and of the specialized processes and plant is required. Moreover, the vast distance of the operations from industrially fully-developed countries requires continuous planning of staff matters, the acquisition and stocking of thousands of tons of stores items ranging from complex technical parts to the more humble but equally important household requisites and food, much of which is deep

frozen and requires modern refrigeration for safe keeping. Processes and equipment have to be maintained and kept up-to-date. All of this calls for clear thinking months ahead of requirement.

The mills each have a full engineering set-up comprising both European engineers and African tradesmen with fully-equipped workshops, so that as much as possible of the maintenance and construction of plant can be done locally. Of particular interest is the exceptionally high degree of accuracy required in the guiding of veneer peeling knives and the highly specialized skill required in the manufacture of the enormous band saws and other types of saws, possessed by the staff of saw "doctors". The quality of the end product depends to a large extent on all the above mentioned special skills and on the enthusiasm and ability of the combined teams of Europeans and Africans, from the general managers downwards to the most humble laborer, all working in difficult tropical conditions.

Sources of energy

The sawmills and the plymill absorb tremendous quantities of energy in the form of steam, electricity and compressed air. To meet these requirements in the remote areas where no public authority supply is yet available, large power stations have been built, fired by the wood waste from the associated manufacturing processes. These power stations have modern boilers equipped with special firing devices for wood waste and large turbo alternators generate electricity which, in the case of the Sapele mill also meets the electricity requirements of the African township of Sapele.

Research

There is a pilot plant and research laboratory at Sapele with one European and one African specialist and a staff of 14 people. Among the important tasks carried out by this unit is the application of research to future projects utilizing wood; testing raw materials and products under tropical conditions; trouble shooting on factory quality/condition problems — i.e., investigating any trouble that may concern the wood during the factory operation, its reaction to humidity, stains, seasoning, the effectiveness of the glue bonds; and the control of organic deterioration of wood — testing antidotes to insects and wood destroying fungi.

FIGURE 5. – *Ancient and modern methods of water travel typify the great timber undertaking of African Timber and Plywood (Nigeria) Limited by the waterside at Sapele.*

Management

Throughout these operations, plant and vehicles are all operated by Africans who have developed a high degree of skill in the work. Africans trained in the arts of management and in the highly skilled techniques required to organize and supervise the maintenance of modern plant and machinery are, however, lacking in sufficient numbers fully to meet the growing needs of rapidly developing countries in West Africa. To help meet this situation, the United Africa Company throughout Nigeria and Ghana has organized its own network of technical training schools, whose work is complementary to that of the government training centers, university colleges and technical institutes. The timber companies have long conducted training courses for selected Africans in forest operations and management, sawmilling techniques and accountancy, under which most of the present African managers have graduated. Much time, attention and money continues to be devoted to the expansion and improvement of these training programs.

Health and safety

In both operations up-to-date clinics or hospitals have been built and equipped, staffed by European doctors and nursing sisters, to provide free medical attention for the employees. All new employees are medically examined before acceptance. One of the doctors tours the concession areas, visiting each unit at least once a month, giving medical treatment to the sick and supervising the work of the African dispensers or dressers who are permanently employed in each area. Water supplies have been laid on and sanitation of a high standard provided, even in the remote forest areas.

Logging and timber working are dangerous operations and, although the African operators are naturally cautious and the accident rate by world standards is very low, accidents do happen. Safety committees, to which both Europeans and Africans belong, are in being, whose work is to examine the causes of all accidents and recommend steps to be taken to minimize the risks of re-occurrence. These committees work in close consultation with the labor/staff or personnel managers.

Staff and administration

The broad lines of policy are laid down by the parent Company in London. The general management in all respects of the two operating companies, some of whose activities in the task of extracting and disposing of more than 1,000 tons of logs per day are described in the preceding pages, is vested in the boards of directors of the two companies domiciled in Nigeria and Ghana.

Between them they employ 5,500 Africans and 180 managers and top grade technical men. Eleven of these managers are at present Africans, mostly engaged in positions of responsibility in production jobs.

The African staff, all of whom are in regular direct employment by the companies, are graded for pay purposes according to the value of their jobs in terms of skill and relative working conditions. Fixed establishments, only alterable at the discretion of management to meet changing needs, are used to control employment throughout the operations. All African staff, including those in the remote forests, enjoy prescribed conditions of employment, available in booklet form. Amenities, such as housing, clubs and sports facilities are provided where these are not already available locally.

Contributory pension schemes are run for the benefit of both Africans and expatriates.

Systems of joint consultation exist throughout the operations, whereby committees including employers and employed sit together to work out improvements in working methods and conditions for the common advantage of all.

It will thus be appreciated that the constant aim has been to bring the most modern techniques to fruition in all aspects of running these very large enterprises which can be said to have pioneered the road for the more widespread industrialization which figures so largely in the thoughts and policies of the governments of the territories, as with independence they strive for the attainment of higher and higher standards of living for their peoples.

Forest Influences

Aldo Pavari
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The influence of forests on their environment forms part of a vast and complex relationship. Arising especially from FAO's Mediterranean development project, a reassessment of current thinking on this matter is now being undertaken, intended to result in publication. In this article, Professor Pavari sets out a general introductory background.

Forests are the most highly evolved of plant formations, and they are also the most exacting. This is particularly true as regards climate and, in fact, the broad lines of world forest distribution are determined by climatic factors. These factors are geographical in their scope. Meanwhile the distribution of forest plants and their varying types within the broad areas determined by climate is affected by edaphic factors; and these, as a rule, are topographical in nature.

The forest demands a minimum of temperature and a minimum of humidity. It has, therefore, two limits: the one is the cold limit, and the other is the xerothermic limit. The cold limit is determined not only by latitude and altitude, but also by the absence of a specific minimum temperature during the growing period. Within the two limits the highly varied forms of forest vegetation can be grouped into broad types which — leaving aside floral and phyto-sociological composition — follow the ecological identity of plant physiognomy. This classification of forests into main types was made by the founders of plant geography; but now there are so many other classifications that it is hard to choose among them. A well-known classification, convenient for our purpose, is that of Brockmann-Jerosch and Rübel. They distinguish the following types of forest:

1. *Pluviisilvae.* These are equatorial, tropical and subtropical " rain forests " which correspond to the climatic zones of continuous rainfall and high atmospheric humidity. They have a preponderance of vascular evergreens and a profusion of tropical creepers and epithytes, mainly of cauliflorous species without leaf-buds.
2. *Laurisilvae.* Like the *Pluviisilvae*, they are found in oceanic climates where the temperature range is limited, where rainfall is abundant and where the periods of summer drought are very short or nonexistent. They consist mainly of evergreen hygrophilous species with leafbuds, but squamifoliate conifers are also present.
3. *Ericilignosa.* This third type of ocean-climate forest is found where the yearly average temperature is fairly low and where the summers are rather cold. These forests are common in South America and South Africa, but they are also represented in the heathlands of northwest Europe.
4. *Hiemisilvae.* They are tropical monsoon forests found in the interior of continents, and their characteristic species put out their leaves only during the rainy season. Unlike the *Pluviisilvae*, they exist in continental or subcontinental climatic zones which have a more or less marked temperature range.
5. *Durisilvae.* These are xerophilous and sclerophilous forests with persistent leaves, and they are found in warm temperate regions which have periods of either summer or winter drought. Characteristic of the first of these types of climate are the Mediterranean and ecologically similar vegetation — Mediterranean maquis, Californian chaparral and South African scrub.
6. *Aestatisilvae.* They are the forest types of temperate-cold climates, typically formed by deciduous broadleaved species (e.g. *Fagus*, *Quercus*) but where coniferous species (*Abies*, *Pinus*) also occur.
7. *Aciculisilvae.* They are coniferous forests of the cold temperate zones. Their plants have persistent and needle-shaped leaves so as to counter the physiological aridity of the winter.

Though these seven types embrace a large number of subtypes, they all show how forest vegetation depends on climate. Within the various formations, however, the forest vegetation modifies the environment — that is, the climate and the terrain — in such a way that it creates conditions favorable to the continuation of its own life. The forest becomes stable when it is at last in genuine equilibrium with the site conditions which it has itself modified.

We ought not to generalize about the influence of forest on environment. On the contrary, we ought to examine the influence of each type among the almost infinite variety of forest forms.

Research

Wherever vegetation first establishes itself on terrain of new formation, we have the primary progressive succession, and this consists of successive phases which correspond to the influence of ecological factors. When these factors are favorable, forest vegetation is also subject to the succession, until it culminates in the balance-formation — that is, the climax. When, through

any intervention by nature or — more frequently — by man, the climax formation is more or less changed in its structure, regressive succession takes place, and this may involve the complete disappearance of forest vegetation. If, however, the causes of the regressive succession cease to operate, a secondary progressive succession will follow; and this, if allowed to develop undisturbed, will lead again to the climax stage. The influence which each stage of growth exerts on the micro-environment — that is, on the site — regulates the mechanism of a succession. Thus the process involves a gradual disappearance of the life-forms typical of each stage and their replacement by those of the successive stage. Only by interpreting forest influences within the framework of these successions can we achieve results of scientific and practical value.

Though there is a wealth of material, only a small proportion of the research has been so far concerned with climax formation. Most of the research has dealt with one or other of the succession phases which we have mentioned, and a fair amount of work has been also devoted to plantations. Whatever value the experiments may have in themselves, they ought to be interpreted and, above all, co-ordinated with the aim of broadly determining the influences of the forest on environment and relating those influences to each type which, in turn, corresponds to the equivalent range of types of climate. Unfortunately, there is a marked disparity between the amount of data on the temperate or cold forests (*Aestatisilvae* and *Aciculisilvae*) and the amount of data on the forests of other climatic regions. Experimental data on the tropical forests is by no means commensurate with their area and importance; and no data were available on the Mediterranean forests (*Durisilvae*) before the launching of a research project in Italy, which was the subject of a report to the IUFRO Congress in Budapest in 1938. Incidentally, this research was of special interest because it led to research on the chaparral evergreens of California which, as we have already noted, are ecologically homologous to the Mediterranean maquis.

Many difficulties beset the experimental worker who seeks to find the precise difference between site environment and external environment and to discover up to what distance the forest can modify its external surroundings. For the data to be completely reliable, there should be no elements in the external environment to disturb the comparison. Not only do these elements exist, however, but their existence is almost the rule. In research on climatic factors, for instance, the comparative method (the comparing of the site microclimate with the external climate) is extremely difficult: for, if the observations in open land are carried out at big distances from the forest, the disturbing elements may well upset the comparison; while, if the tests are made near the forest, its influence may intrude and, in like manner, change the terms of comparison. For this reason, the historical method came to be used in the United States, especially for hydrological research; and it was afterward adopted in other countries.

The historical method has two main features. The first is the observation, throughout a number of years, of the climatic features over a chosen area of forest and a chosen area of open land. The second is the subsequent elimination of the forest and the observation for a further period of the climatic changes which follow, always comparing them with the climatic features of the chosen area of open land. One conspicuous example of the use of the historical method was given by the Wagon Wheel Gap experiment in Colorado, in the United States. Temperatures and other climatic data in two similar watersheds were measured for seven years. Then one watershed was denuded of forest and the measurements were continued for another seven years. The first period served as a control for the comparisons with the second. The results have been published in the original report [1] and elsewhere.[2]

This method may not remove all sources of error or overcome the necessity to be extremely cautious in drawing conclusions. The process is lengthy and can be expensive. It may tempt people to take a pessimistic view of the research which has so far been made. Yet, without a doubt, the research has a real value. The data now collected enable us to see the problem in a very different light from that of a few decades ago.

Influence on Climate

Forest influences can be divided into three practical as well as scientific groups — the influence on climate; the influence on soil; and the influence on water resources.

Solar radiation and air temperature

One of the main factors of a forest microclimate is solar radiation. Since the sun's rays bring not only light but heat, the decreased light within a forest must be accompanied by lower temperatures unless these are modified by other factors. In wet tropical forests, where heat is continuously — indeed, limitlessly — available, the forest cover may be of very high density; it admits a minimum of light and hence of heat. Towards the colder limits, the forest cover becomes thinner. Thus it admits a greater quantity of light into the forest — and particularly to the soil — so as to supply the conditions which are indispensable to the forest's existence and to its natural regeneration. This situation, which is due to the need for solar heat, has further effects on other forest influences. In the denser and shadier forests, for example, precipitation is more fully intercepted, temperature ranges are narrower and wind speed is more restrained. The same phenomenon of thinning is noted towards the xerothermic limits.

A second factor of a forest microclimate is air temperature. Forests of the *Aestatisilvae* and *Aciculisilvae*

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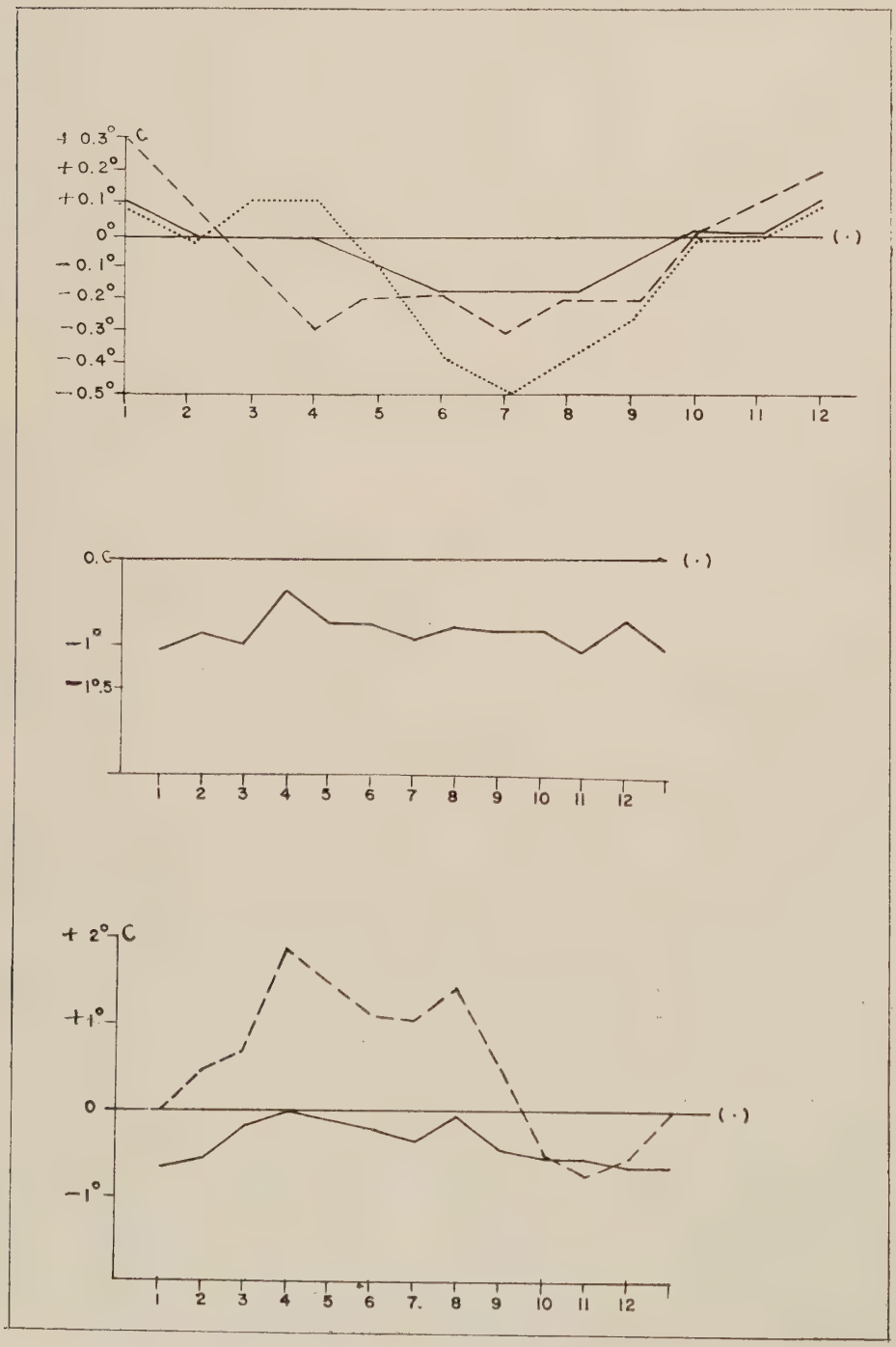
[1] Bates, C. G. and Henry, A. J. "Forest and Stream-flow at Wagon Wheel Gap, Colorado. Final Report." *U.S. Monthly Weather Rev. Suppl. 30*:1-79. 1928.

[2] Kittredge, J. *Forest Influences*. 1948.

types modify the extremes of air temperature, especially in the layers nearest the soil. This modification usually consists in a reduction of maxima and an increase of minima; indeed, the winter temperature in the forest does not differ appreciably from that in the open. A more usual — and commonly known — fact is that the interior of a forest is cooler in summer than its exterior, especially when the forest is dense and shady. Yet, as research on Mediterranean forests has shown, this is by no means a general rule. In fact, the research has led to a different and, perhaps, more rational interpretation of the causes which underlie the influence of the forest upon air temperature.

This new interpretation was suggested by an examination of Schubert's [3] graph (Figure 1a) on the Norway spruce, the Scots pine and the beech; they mark the differences in average monthly temperatures between forests of these species and open land. The curves do not show the actual temperature variation, but the differences of forest temperature above or below those in the open; and those in the open are represented by a horizontal line. According to the graphs, the Scots pine causes a very slight drop in the summer temperature of the interior (2° C. less than the open),

[3] Schubert, J. *Der jährliche Gang der Luft - und Bodentemperatur im Freien und im Waldungen* (Yearly Variations of Air and Ground Temperature in Open Country and in Forests) - Abh. des Preuss. Meteorolog. Inst., 1900-1901.



Key A

- - - - - *Norway spruce*
——— *Scots pine*
. . . . . *Beech*
(.) *Open*

Key B

——— *Pine stand, Migliarino, Italy*
(.) *Open*

Key C

——— *Pine stand, Cecina, Italy*
- - - - - - Forteto, *Cecina*
(.) *Open*

Figure 1. – *Comparison of average monthly air temperature in forest and in open land. Open land is represented by the horizontal line. (After Schubert).*

and in the winter it exerts almost no effect. Meanwhile the Norway spruce brings down the temperature of the interior appreciably in the summer and raises it in the winter (nearly 3° C. over the temperature of the open in January). The beech is the most effective of the three species in reducing the summer temperatures. On the other hand, it keeps the inside air warmer than the outside air not only in winter, but also in spring. For example, it is 1° C. higher in April.

Despite all these marked differences, the graph confirms the general effects noted with cool temperate forests of the *Aestatisilvae* and *Aciculisilvae* types — the lowering of the monthly average temperature in summer and its raising in winter. These differences cannot be explained solely in terms of physical causes. No doubt the forest canopy acts as a nonconductor in intercepting the sun's rays; it damps down air movements and slows up the radiation of soil-warmth. Yet it is not really possible to explain why the summer temperature is brought much lower in a beech forest than in a spruce forest unless we go beyond the physical action of the various forest covers and consider another element — physiological action. For in physiological action we must include transpiration.

Transpiration causes loss of heat and during the growing season this must bring about a loss of temperature. The more intense transpiration becomes, the greater loss of temperature will be. The soundness of this hypothesis is confirmed by Schubert's graph; for, of the three species, the most hygrophilous in nature is the beech, and the most xerophilous is the Scots pine. The Norway spruce comes midway. Experiments, in fact, have shown that the beech transpires the greatest amount of water, while the Scots pine transpires the least. Again the Norway spruce comes midway.[4] Logically, therefore, the lowering of temperature from spring to autumn should be directly proportional to the intensity of transpiration. This the line of the graphs fully confirms.

The part which physiological action plays in determining the differences of temperature within and outside the forest is indicated by the very common sensation that the temperature of a Mediterranean forest in summer seems to be higher than it is outside. This is a complete contrast to the sensation experienced within the forest of a temperate or cool climate. It might be supposed that this opposite sensation is due to the very sluggish movement of air within the forest; but, on the contrary, experiments have shown that the more markedly xerophilous are the Mediterranean forests, the more their influences differ from this pattern.

Graphs (Figures 1b and 1c) show the curves of monthly temperature, compared with the open, of three different types of Mediterranean forests: the pinewood of Migliarino and the pinewood and *forteto* of Cecina. The wood at Migliarino consists of stands of *Pinus pinea* with an underwood of *Quercus ilex*. The site, which is very damp and, indeed, marshy in some places, can be regarded as mesophilous. The pinewood at Cecina also consists of *Pinus pinea*, but the soil is dry and sandy, and it has a far deeper water-table. The wood is near the sea, and its site, together with the action of the wind, gives it a xerophilous character. The Cecina *forteto* is a coppice composed of holm oaks and other species typical of the Mediterranean maquis, and they make it dense and impenetrable. The vegetation and the aridity of the site give the wood a character which is distinctly Mediterranean and xerophilous.

Within the Migliarino pinewood the average temperatures — unlike those within the forests of Central Europe — remain steadily lower than the exterior temperatures throughout the year. The differences, however, are very small, for they are less than 1° C. This shows that the physical effects of the tree cover — which, by impeding radiation, ought to raise the winter temperature above the temperature in the open — are nullified completely because the mild climate and the humidity encourage all-the-year-round growth. Hence they also stimulate transpiration. The result is, indeed, a loss of heat, through transpiration, and the temperature becomes lower, however slightly, than the temperature outside the wood.

The pinewood at Cecina shows a similar behavior; it tends steadily to lower the temperature. Here, however, another fact is noted. In the spring and summer, the interior temperature rises in equal measure with the exterior temperature; for the activity of transpiration has been slowed down by dryness. In the autumn, the curve of minus variations is markedly lower; and this corresponds to the renewal of growth which is started by the autumnal rains.

Meanwhile, the graph for the Cecina *forteto* accentuates the part played by physiological action. Here the differential curves follow a course directly contrary to the course of the forests in Central Europe. In the coldest months of the winter the temperature roughly equals that in the open. Between spring and summer there is a rapid rise, which culminates in April and May. Thereafter follows a slight sagging in the summer months, although the temperature always remains about 1° C. above the exterior temperature. In October there is a sharp decline, and in the autumn months the temperature falls to about 1° C. below the external temperature.

For this there is an explanation. In the *forteto*, as in all xerophilous woods, transpiratory action is greatly reduced in the hot season from spring to autumn. As a result, transpiration is itself reduced; and herein lies the process of xerophilous adaptation. Since transpiration is no longer effective, the nonconducting action of the thick evergreen canopy causes the temperature within the coppice to rise above the temperature outside; but as soon as the first autumn rains stimulate growth again, transpiration comes once more into play and the temperature falls.

[4] The figures given by Kittredge (1948) show the following consumption of water by transpiration during a growing season: beech 10.8 inches (27.4 centimeters), Norway spruce 8.3 inches (21 centimeters), Scots pine 2.9 inches (7.4 centimeters).

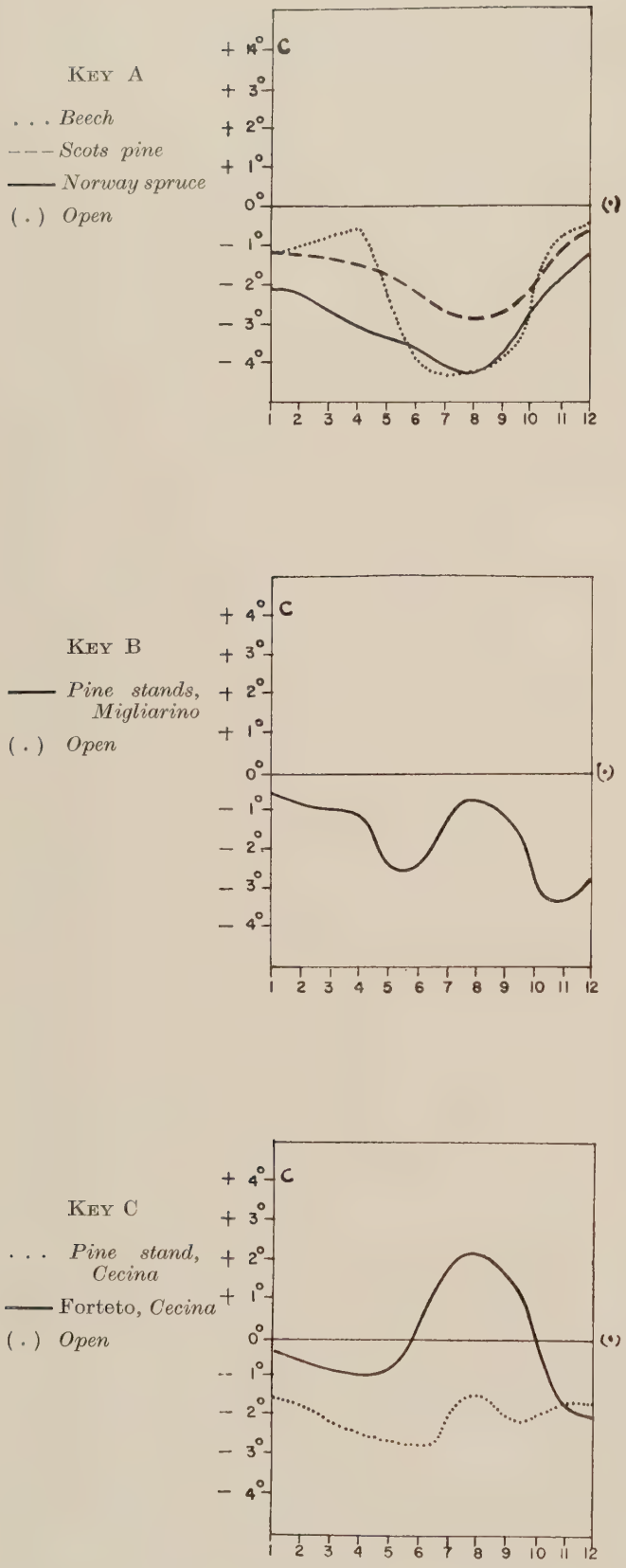


Figure 2. – *Comparison of monthly temperature ranges. Temperatures on open land are represented by the horizontal line.* (*After Müttrich*).

It is instructive to examine the graphs in Figure 2 which shows the curves of temperature ranges, compared with open land, in woods of beech, Norway spruce and Scots pine (Figure 2a). For each species the reduction of the monthly range reaches its peak during the growing period, though beech brings about the maximum reduction and the Scots pine brings about the minimum. In the three Mediterranean woods, however, the situation is very different. In the pinewood of Migliarino (Figure 2b) as in the three mesophilous woods, a reduction in ranges takes place throughout the year but, together with the pinewoods of Cecina (Figure 2c), it follows a different course. In the *forteto*, on the other hand, temperature ranges during the summer and the autumn are greater than in the open. This is due to the rise in daily maxima; for the non-conductive effect of the canopy is not compensated by the loss of heat through transpiration.[5]

A situation exactly similar to that in the European mesophilous forests has been noted even in other continents. In July a drop of 6° F. was registered in a climax forest of mixed *Pinus strobus* in Idaho, while a wood of *Tsuga canadensis* in New York State showed a drop of 4.8° F. On the other hand, in a Colorado forest of mixed *Picea engelmanni* and *Populus* at an altitude of 9,000 feet, the drop in the July temperature was barely 1° F. Of all the species which we have mentioned, the beech is the greatest consumer of water through transpiration.

As for the nonmesophilous woods, Pearson has noted that in the woods of *Pinus ponderosa* in Arizona and New Mexico there was, in July, no difference between the temperatures of forest and open. Meanwhile, Munns' researches on the Californian " chaparral " show a behavior similar to that of the Mediterranean *forteto*. In fact, the summer peak temperature in the chaparral exceeds that in the open by 7° F. and the daily ranges are as much as 10° F. higher. The average of maximum temperatures for July is 5° F. higher than that in the open. Kittredge (1948) attributes this to the stagnation of air caused by the low dense canopy. Though this factor is certainly operative, it is linked with the lack of transpiration; and this is confirmed by studies of the nearby forest of *Pinus jeffreyi* in which Munns made parallel observations. Peak temperature is barely 1° F. higher than in the open. This shows the xerophilous nature of the forest.

Wind, humidity and temperature

A third factor in the influence of the forest on climate is wind. Since wind action is mainly due to the density and development of the canopy and to the

[5] The validity of the hypothesis here advanced should have been supported by direct monthly measurements of transpiration but, apart from the difficulty of making these measurements, the task was rendered impossible by the wartime destruction of all the meteorological stations which would have been used to plot the courses of temperature and transpiration.

density of the stand, it is obvious that the reduction of wind speed inside the wood is proportionate to these conditions. The type of forest, in other words, makes no significant difference. Yet it is worth pointing out that deciduous stands stripped of their leaves exert much less influence than when they are in leaf and that the thinning of the canopy has other more or less marked effects, apart from adding to the movement of the air. Chief of these effects is the increase of evaporation and the consequent drying influence in hot arid climates. The effect in cold climates, however, is that of increasing temperature ranges and, in particular, of lowering minima.

Incidentally, the mean annual percentage wind velocity compared with the open in the pinewood of Cecina is 44; in the pinewood of Migliarino it is 17; and in the *forteto* it is 11. On days of high wind there is an almost complete stillness inside the *forteto*. This, together with the greatly decreased transpiration, explains why the summer temperature inside the *forteto* so greatly exceeds that in the open.

A fourth factor in the influence of forest on climate is the humidity of the air; and while it is apparently agreed that relative humidity cannot indicate the actual air humidity since it is bound up with temperature, it is worth while to trace the differences of behavior between temperature and relative humidity in various types of forest compared with open land. In xerophilous forests, for instance, the most marked ranges of daily temperature are matched by the ranges of atmospheric humidity. It is also significant that there are differences of atmospheric humidity inside and outside the forest while temperatures are roughly equal. Here, too, we find a confirmation of the differing intensities of transpiration in the beech, the Norway spruce and the Scots pine. From data collected in Switzerland and Germany, we get the following percentage figures for the increase in relative humidity over the open in the summer months — that is, in the period of maximum transpiratory activity. For beech, the percentage figure is 9.35; for Norway spruce, it is 8.56; and for Scots pine, it is 3.87. For the larch, incidentally, the percentage increase was 7.85. This figure confirms the results of other tests, which have all shown that the larch emits large quantities of water through transpiration.

A fifth factor is soil temperature. The forest cover attenuates soil heating and radiation not only according to the type and density of the cover, but also according to the properties of the terrain. There is also the mitigating effect of these forests on temperature ranges by lowering maxima and raising minima. This influence is important because it affects the top horizons in which very significant biological processes take place. Mediterranean forests, too, have a notable influence on soil temperature, though it differs from the general pattern found in the forests of temperate and cold climates. Even though the differences may be due to soil properties — a highly important factor — they are worth recording. In the Cecina pinewood, the summer and autumn temperatures at a depth of 20 centimeters are lower than in the open; but in the winter — at the same depth — the temperatures remain somewhat higher than in the open. The same phenomenon is found in the Migliarino pinewood; but here it is more marked, and it operates to a depth of 50 centimeters. Meanwhile, the temperature within the *forteto* is lower than the temperature in the open all the year round down to a depth of 50 centimeters. In the summer the minus differences at a depth of 20 centimeters are as much as 7° C. In other words, the influence of the Mediterranean forests resembles that of other types of forest in the summer, but it differs from them in the months of the autumn and the winter, when the temperature remains lower inside than outside the forest. Even in the Mediterranean woods, however, the ranges of temperature are modified. To a depth of 1 meter, moreover, heat penetrates the soil much more slowly than on damp sites.

Rainfall

The sixth — and most important — factor in the influence of the forest on climate is rainfall. It is a complex and controversial subject. A major element is the forest's power of interception. There is a difference between rainfall in the open and rainfall beneath the forest canopy; and rainfall beneath the forest canopy is usually expressed as a percentage of rainfall in the open. The gauges which measure rainfall in the forest, however, do not take into account the water which runs along the foliage and down the trunk. This stem flow, as it is called, must be measured separately with special equipment. By subtracting this amount from the interception percentage, we have the interception loss. The ratio between the two terms varies greatly according to the types of forests. In the Mediterranean *forteto* the interception total is 35 percent, and in the Californian chaparral it is as high as 38 percent. In the Californian chaparral, however, 30 percent of the fall is not intercepted by the canopy and re-evaporated. Instead, it reaches the ground as stem flow, and thus the interception loss is only 8 percent. In another type of chaparral, out of an interception of 19 percent, 8 percent consists of stem flow, and thus the interception loss is only 11 percent. Stem flow has not yet been measured in the Cecina *forteto*, but it is probably just as high.

Stem flow increases the moisture-content of the soil; for such a slow and widely spread influx of water cannot add to surface run-off like rain which falls directly to earth through the canopy. To explain the part which interception plays in a complex process, we can say that while interception loss represents a definite loss of rainfall, stem flow makes for the enrichment of the forest soil humidity. None the less, views diverge on the importance of interception in the hydrological cycle, especially since experiments in Switzerland led Engler to conclude that, so far as run-off from forest lands is concerned, interception is of secondary importance compared with factors like the

permeability and porosity of the forest land. Generalization should be avoided. Yet it is only logical that, in a broadleaved deciduous forest, interception is much greater when the trees are in leaf than when they are stripped in winter. When, for instance, the beech is in leaf, interception can be over 40 percent; when the beech is stripped in winter, interception is only 19 percent. This, in its turn, varies with the prevalent rainfall.

In the Mediterranean, rain falls mainly in the autumn and the winter, and it is often intense and torrential. In European continental climatic regions, however, rain falls mainly in the summer, and it is not usually intense. Now there are many types of forest common to both of these broad climatic regions. Beech woods, for example, are found on Mediterranean uplands like the Italian Appennines and on the plains of Central Europe. Yet, as far as interception is concerned, similar beech-groves act very differently in these two environments. The Appennine stand is stripped and, therefore, almost powerless to intercept in the autumn and the winter when rainfall is most frequent and heavy. In Central Europe, on the other hand, the beeches retain their maximum interceptive power, for they are in full leaf during the summer when rainfall is heaviest.

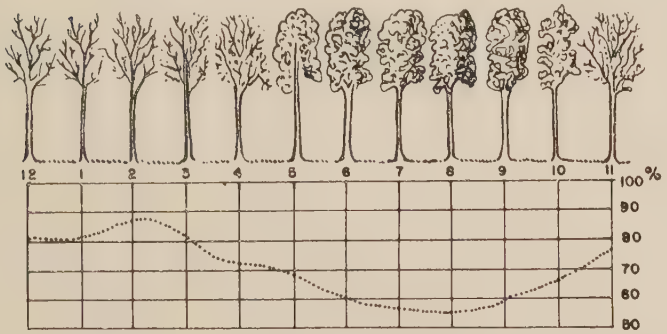


FIGURE 3A. – *Interception variation in a beech forest under two types of rainfall distribution, December - November. (After Schubert.)*

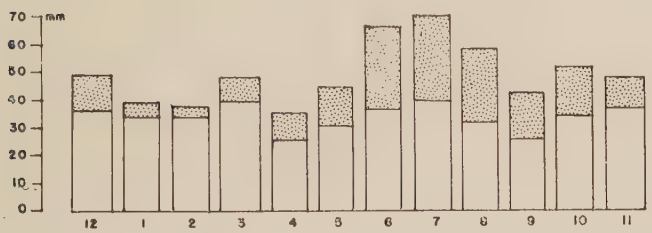


FIGURE 3B. – *Intercepted (etched section) and nonintercepted (white section) rainfall according to the above-mentioned percentages in a beech forest near Berlin.*

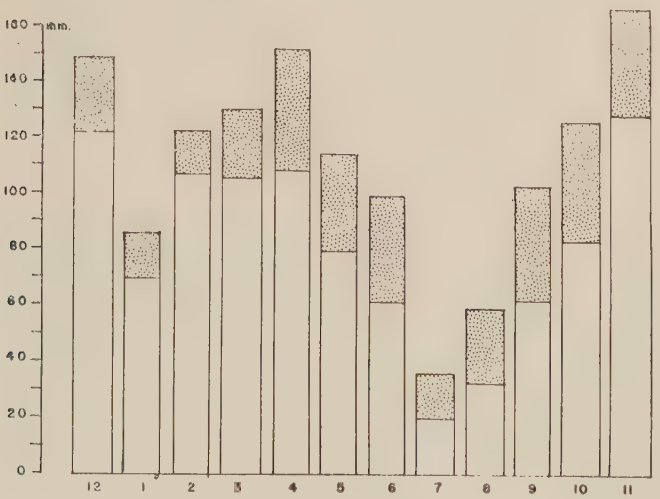


FIGURE 3C. – *The same phenomenon as in Figure 3B in a beech forest in the Tuscan Appenines, Vallombrosa, Italy.*

The reality is very different, for interception cannot be equal in Vallombrosa and in Berlin. Interception is inversely proportional to the intensity of the rainfall. In woods of beech (as of any other broadleaved deciduous species) growing in a Mediterranean climate with its typically torrential winter rains, interception is, in practice, extremely low during that season. Thus it has little effect on checking run-off.

Even less effective are stands of oak and, in particular, sweet chestnuts, for they are less dense. Evergreen vegetation, on the other hand, plays an important part in the Mediterranean climate with its concentration of rainfall in the autumn and the winter, so long as this vegetation is as dense as it is in the maquis and similar formations. In the maquis, interception reaches very high figures. A large proportion is explained by stem flow; and, under these conditions, incerception becomes an extremely important factor in the hydrological cycle. Incidentally, a tree canopy may influence interception more through its spread than through its density. The pinewood at Cecina was 77 years old and had about 400 trees per hectare when the percentage of interception for 1932-35 was found to be 26.3. The wood at Migliarino was 55 years old and had only 95 trees per hectare when the percentage of interception was found to be 37.7.

The different types of forests behave differently even in the matter of evaporation, for they combine their own action with the reciprocal action of the climate. A similar plant cover will bring about a steeper reduction in evaporation, as compared with bare land, where the climate is warm and windy. The reduction will be much greater, for example, in Mediterranean than in Oceanic or continental climates. In the Cecina pinewood, the yearly reduction in evaporation is 42 per-

cent of that from bare land. At Migliarino, it is 53 percent, and in the evergreen *forteto* it is about 60 percent.

If we pass from annual to monthly averages we find that in hot dry climates the forest's influence is very intense during the summer as well as during those months when strong winds prevail. In an Arizona forest of *Pinus ponderosa*, in fact, the evaporation reached 70 percent of that in the open;[6] and this figure has often been exceeded in the Cecina *forteto*. According to the period when the rains fall, this sharp drop in evaporation inside the forest can have very varied effects on water supplies. When the summers are dry, it has a negligible effect on run-off, while it is beneficial to forest growth. In the rainy season, on the other hand, the decrease is in inverse proportion to interception. Thus decreased evaporation can result in a greater run-off from wooded than from bare land. Incidentally, so far as total water supplies are concerned, evaporation and transpiration should be studied together, for their effects may be cumulative or complementary. Experiments in the United States have shown that while cutting the undergrowth increases evaporation, it eliminates the loss of water which the undergrowth caused through transpiration.

Tropical forests

The most luxuriant and the most typical of the tropical forests are the evergreen forests of the equatorial and wet tropical forests. They are known as the tropical rain forests, and the climates which foster them have constant high temperature of only a slight range. Annual mean temperature varies between 20° C. and 28° C. and the annual average of monthly ranges is about 5° C. In some areas the annual average of monthly ranges is as low as 1° C. Daily ranges go from 3° C. to 16° C. Maxima on the equator rarely exceed 33° C. to 34° C., while they may be as high as 50° C. in the tropics. Annual average rainfall exceeding 2,000 millimeters may be sometimes as high as 4,000 millimeters; occasionally it is even over 10 meters.

Rainfall is fairly uniform because, even though seasons known as wet and dry may occur, monthly rainfall is over 1,000 millimeters even in the drier months. In any event, periodicity of rainfall has less influence on types of forest than on the biological cycle of the flowering and fruiting times. The rainfall limits of the wet tropical forest are approximately 1,650 to 1,900 millimeters annually with monthly averages of 200 millimeters.[7] Atmospheric humidity is generally high; it reaches 93 to 94 degrees and is rarely below 70 percent, but the high temperatures lead to very high saturation deficits. Except for the hurricanes, tornadoes and typhoons, wind strength is usually less violent than in the temperate regions.

It might be inferred that the microclimate inside a tropical forest does not differ appreciably from that outside; but there is a need for experimental records, and these are extremely scarce. The internal microclimate of tropical forests has been fairly studied, though not over long enough periods, but data which compare the internal and external microclimates are most rare. One of the uncertain elements in comparing tropical forests with the forests of cold temperate climates is temperature gradient — that is, the variation of temperature according to the height above the ground. There is the jungle in the Panama Canal Zone, where the temperature gradient between 0.60 meter and 46 meters above the ground shows a variation of barely 2° C. at noon and 1.7° C. at six a.m. Elsewhere in the very diverse tropical forests, however, we find that gradients are much more marked and irregular. In the dense undergrowth we usually get, at a height of 1 to 2 meters, a much lower temperature. This increases gradually toward the underwood canopy and is greatest above the canopies at the dominant tree level, with a difference of 5 to 6° C. It is evident, Richards declares, "that more than one type of temperature gradient exists in the rain forest." [8]

It is certainly logical to assume that temperatures in the lower levels of the forest differ more from external temperatures than those taken at the level of the canopy

Table 1. – Air Temperature

	In open	Under forest	Difference
	..... *Centigrade*		
Annual mean of maxima	32.1	28.4	–3.7
Annual mean of minima	21.4	22.5	1.1
Difference	10.7	5.9	–4.8
Maximum diurnal range	18.5	13.5	–5.0
Minimum	1.0	0.3	–0.7
Difference between extreme maximum and extreme minimum for whole period	27.7	24.0	–3.7

Table 2. – Relative Humidity

	In open	Under forest	Difference
	..... *percent*		
Mean annual at 6 a.m.	97.9	96.7	–1.2
Mean annual at 2 p.m.	67.1	82.3	15.2
Difference	30.8	14.4	–16.4
Greatest difference between mean monthly at 6 a.m. and 2 p.m.	51.8	42.9	–8.9
Smallest difference between mean monthly at 6 a.m. and 2 p.m.	10.7	2.7	–8.0
Difference between extreme max. and extreme min. at 2 p.m. for whole of period recorded	77.0	72.0	–5.0

[6] Pearson, 1931.

[7] Only 60 millimeters, according to Köppen.

[8] Richards, P. W. *The Tropical Rain Forest.*

of the dominant species. Atmospheric humidity should vary according to the same law; and similarly light should lose some of its intensity — while yet remaining very bright — according to the varying density and structure of the levels of vegetation. One of the few comparative observations was carried out by Carton and Sallenave in the experimental forest of Trang-Bom in Indo-China. Some of the results of the observation period from 1933 to 1937 are shown in Tables 1, 2 and 3.

Table 3. – Evaporation

	In open	Under forest	Difference
	..... *in millimeters*		
Total for mean year	702.2	297.5	-404.7
Highest monthly total	126.4	67.1	-59.3
Lowest monthly total	26.2	6.6	-19.6
Mean total per 24 hours	1.9	0.8	-1.1
Maximum per 24 hours in whole period	8.3		

Meanwhile P. H. Gerard has studied a secondary forest near Bambesa in the Belgian Congo. It has a very complex constitution; and here are some of the main observations for the period 1952-53, comparing forest with open land.

> "Air temperature is reduced, seasonal variations are parallel, the influence of tropophily is appreciable. Water vapor tension is always higher and saturation deficit very feeble. Soil temperature is always lower, daily range much lower and seasonal range marked. Rainfall interception by the forest is 14.2 percent of the amount registered by 6 rain gauges situated in a radius of 10 meters round the site, and 23.7 percent of that measured by 23 gauges set up in the same radius and for the same period. Evaporation levels are low and parallel with those in the open. The average of monthly figures under forest is 25.4 percent of those obtained in the open under shelter and 15.2 percent of those in the open without shelter. The percentage of night evaporation is higher under forest than in the open. Wind speed inside the forest reached, for a short time, 5 percent of that outside.
>
> These data, which do not include those on light and wind velocity in the forest, are representative of only one type of forest microclimate. It is quite certain, however, that each kind of formation has its own microclimate."

Gerard's observations show that, like the hygrophilous and mesophilous forests of temperate lands, the tropical forest also lowers the mean annual temperature chiefly by reducing minima and, at the same time, it decreases the annual, monthly and daily temperature ranges. The differences of relative humidity are slight. They are also of little significance, for in tropical climates the chief ecological influence is exerted by the saturation deficit. On the other hand, evaporation, as the very dense canopy leads one logically to assume, shows a steep decline. The decrease in evaporation means an enrichment of the water system, but transpiration works in the opposite way, even though it helps to increase the air humidity — at least, within a certain radius.

There exist a few studies of the coefficient of evaporation-transpiration. Thus Bernard, in his 1953 report,[9] has calculated the mean annual evapo-transpiration for the immense forest zone of the Belgian Congo, which covers a million square kilometers. He used the standard formula: $(E+T) = (P\text{-}D)$, where $E+T$ equals evapotranspiration, P equals rainfall and D equals run-off. On the basis of this formula, the evapo-transpiration for the savanna is about 1,025 millimeters, and for the equatorial forest it is about 1,500 millimeters.

Another method of calculation is the energy balance. This method is familiar to geophysicists and was first applied to problems of lakewater evaporation. It is based on the calories per gram per centimeter of horizontal surface for the evaporation of 1 millimeter of water. The basic formula for this calculation has as a chief coefficient the *albedo* or ratio between reflected and total radiation. The *albedo* in the forests is seldom known, but the first figures acquired through the use of aeroplanes and helicopters have shown variations from 3 to 10 percent.

Bernard rightly recommends a joint research project on the *albedo*; for this is an essential factor both in working out the energy balance and in making any successful research on the hydrological influences of the forest. If, he points out, evapo-transpiration is considered fundamentally as a question of energy, it becomes independent of the plant mass which fosters evaporation and transpiration. A grassy cover a few centimeters high, in fact, can evapo-transpire more than a dense equatorial forest of 30 to 40 meters' stands; and this has been confirmed by experiments made on regularly watered covers of *Paspalum notatum* of various heights. The results point to a water consumption not far from the approximate 1,385 millimeters calculated for the Congo forest. In other words, the influence of these enormous forests does not differ greatly from the influence of grasslands or savanna. The experiment gives strength to the theory that the equatorial forest is the effect, and not the cause, of the heavy rainfall in the Central Congo depression.

In the tropics are many varieties of transition-types between forest and savanna, which is grassy formation with scattered trees. The dividing lines of transition may start from the wet tropical forest or from the deciduous forest. Large stretches of savanna are not ecologically indigenous; for they are the result of a forest regression which, as a rule, has been caused by

[9] "The annual evaporation and transpiration of the Congo's equatorial forests and their influence on rainfall," *Report of the 11th IUFRO Congress*. Rome 1953.

fire. The regression has been extremely widespread, especially in Africa and in South America. It is thus difficult to distinguish the real ecological frontiers between forest and savanna; and these frontiers, in turn, vary with the climatic conditions. There is not enough experimental data on the tropical deciduous forests to permit us to draw comparisons with the microclimates of the other main forest types.

It is, none the less, logical to suppose that tropical deciduous forests which are in leaf during the rainy season exert their maximum interceptive power in that period. It is also logical to suppose that they have many actions in common with other forests; for example, the reduction in light intensity, which naturally reaches its maximum in the growing period, and the lessening of wind-speed and evaporation. These actions, it is clear, depend on the density and the structure of the tree-cover. Their effect will gradually weaken as the tree-cover becomes more sparse and, at last, merges into savanna.

Long-distance effects

The forest edge, it is well-known, shows special conditions which can be called a "fringe microclimate" and which may have some importance for the croplands adjoining the forest. This fringe microclimate differs from the internal and external microclimates in showing a more marked temperature range, which is due to reflection. The experiments in the pinewoods of Cecina and Migliarino and in the *forteto* have shown, compared with outside temperature, an increase in the summer maxima of 1° C. in the pinewoods and about 2° C. in the *forteto*.

The Italian scientists, however, have experimented on another important problem. This is the transmission of the forest microclimatic features vertically, instead of horizontally. They sent weather balloons with recording instruments up to a height of 1,000 meters. The experiments were suggested by the effects which pilots had long noted when flying over wooded country. They were also suggested by the elementary physical law that warm air currents rise and cool ones descend, while none of them work horizontally except through the action of the wind.

The results of the experiments showed that very different influences were exerted by the most mesophilous forest — the pinewood of Migliarino — and by the most xerophilous forest — the *forteto*. Compared with the open, the temperature above the pinewood of Migliarino remained constantly lower up to 500 meters and the maximum differences were shown during the night. At 1,000 meters, on the other hand, these differences became less marked and they were appreciable only during the morning. In other words, the peculiarities of the pinewood's microclimate — that is, a lower temperature than the temperature outside, due mainly to transpiration — make themselves felt up to rather more than 500 meters. Yet over the *forteto*, where summer temperature is higher than outside, the warmer conditions are communicated to the air to a height of 500 meters, and the difference in temperature can amount to 3 or 4° C. This warming of the air above the wood occurs more gradually and with lower ranges than outside the wood. At 1,000 meters, the effect is attenuated in the sense that the night temperature — that is, the temperature from the afternoon to the following morning — remains above the temperature over the open. From early morning to noon it falls.

One of the forest's chief long-distance effects is the stemming of wind velocity. People have long been aware of the beneficial effect of forests upon agriculture where croplands alternate with more or less scattered wooded zones, and a large body of data is now available on the influence of windbreak belts. Italian experiments have shown that, even when a forest covers a big area, wind-protection is limited to a distance from the fringe equal to 10 to 12 times the height of the trees. Nägeli reached similar conclusions in Switzerland.

A keenly debated question is whether the forest can bring about increased rainfall or, at least, make for its better distribution. We must distinguish between local influences and long-distance action. Local influence depends mainly on the effect which the cooling of the air above the forest may have in modifying the saturation deficit, independently of any increase in humidity in the air above the forest. When the saturation deficit is very low, the slight drop in temperature might increase rainfall to something like 2 to 3 percent in some temperate areas which are mountainous or have cloudy summers. In hot climates, however, when the saturation deficit is very high, any cooling of the air which the forest might cause would not be sufficient to bring about rainfall.

In the Mediterranean forests, we have seen, this cooling does not take place. On the contrary, the air above the forest is warmer. Hence, absolute humidity being equal, saturation deficit is increased. Another local influence on rainfall is the slowing-down effect which the forest can have on air currents already charged with humidity to the point of condensation. This braking and friction of the air currents by the forest canopy can be called "orographic effect." It is hardly felt in mountainous areas, but in the temperate lowlands it can produce an increase up to 3 percent in local rainfall.

Many still assume that the forests increase — or, rather, improve — the distribution of rainfall over vast areas. This is a most debatable problem, and it remains unsolved. Even excluding the other numerous factors — some, perhaps, not fully understood — which may affect rainfall, it is hardly logical to attribute to the forest a vast influence when its local influence is so obviously modest. Rainfall systems are determined chiefly by rains which are cyclonic in their nature and by the broad patterns of upland contours. By comparison, the forests play only a subsidiary part. The

forest exerts a weighty influence on soil and water conservation. In other words, it exerts a weighty influence on the balance of nature and on human life. There is little need to invest it with other influences which are still hypothetical.

This uncertainty applies not only to these forests, like the cool temperate ones, where there has been substantial research; it is equally true of the little-studied tropical forests. It is unlikely that forests in wet equatorial and tropical regions (including those in mountainous zones) can exert an appreciable influence on rainfall. In view of the high deficit in atmospheric saturation, it is no less unlikely in arid tropical climates. Carter and Sallenave state that "the grave consequences of deforestation in arid climates, or climates with periodical aridity, are due not to changes in the general climate, but to destruction of the forest microclimate. The microclimate of forests directly conditions their soil climate, and both of these are vital factors in the turnover of organic matter and the water regime of the soil." "There are indications," Hughes writes, "that the presence of forests may increase local rainfall, but effects on a regional and continental scale have not been demonstrated. It is on this most important aspect of forest influences that our knowledge is least satisfactory."[10]

Influence on Soil

In the various phases of the forest's progressive succession towards the climax, the corresponding plant associations modify the site and prepare the way for the associations typical of the following phase until the climax is reached. The same process occurs during the regressive succession after the change in, or the disappearance of, the climax formation. In the last phase of this regression, erosion may cause the complete disappearance of the forest soil. Yet in every type of climate (except near the cold and xerothermic limits) wherever the progressive succession of forest vegetation is allowed to evolve without outside interference, above all by man, the forest supplies the most complete and most efficient defence of the soil.

It is true that erosion cannot be completely eliminated because it is part of the broad natural law whereby the earth's relief is slowly molded. But it is equally true that, for practical purposes, the forest's protective plant cover reduces erosion to a minimum. Even small forest plants (the scrub and bush of the hot arid regions, for example) offer a valuable defense as long as they are fairly dense. Against other soil movements (especially landslides) forests do not always act as defenders. Some of the interferences with a forest are self-evident, and these include the destruction of large areas by fire, by avalanches or by violent winds. Other interferences, though less visible, can have a major importance, especially when they have been active over a long period. Typical of these interferences is the cutting which more or less changes the forest's natural structure. Another is forest grazing. This causes trampling, which hardens the topsoil and involves a loss of porosity and impermeability. Those who assert that the forest does not offer enough defense against erosion should remember that the forest has been more or less degraded, even though this is not outwardly indicated by the forest cover.

The soils in tropical forests differ sharply from those in forests of other types. The most commonly found is the laterite soil with a scanty surface layer of humus. Although the rain forests have an enormous mass of foliage, their leaf carpet is thin. It is, in fact, barely 3 centimeters thick for (like the other forest refuse of twigs and bark) the leaf is speedily converted into humus. Except where it accumulates in small depressions, the content of the organic matter, even in the lowland rain forest, is barely 1 to 2 percent of a surface layer of about 10 centimeters. This is due to intense and complex action by organisms and to the purely chemical process of oxydization.

It is surprising that, in spite of the continuous leaching of the soil and the loss of its mineral components, the vegetation of the tropical forest is so much more lush than the vegetation on richer soils in arid climates or in the savanna. The richest mineral nutrients, however, are found in the upper layers which are continually fed by plant waste; and here the greater part of the root systems is developed.

Subsoil rock is more important for drainage than as a source of minerals, and the richness of the topsoil can be easily dissipated, once the cover is interrupted — the more so when the forest is burned or felled to make way for cropland. This speedy loss of fertility has been noted all over the world. In British Honduras, where the annual rainfall of about 1,800 millimeters is not too heavy, the maize harvest on former forest land dwindles to one third or one quarter by the third year. Brazilian coffee plantations provide another example. The exhausted soils can be restored by fresh plantation, however, so long as the species differ from those of the former forest.

There is a marked contrast between the influence of the forest and the influence of other plant covers, especially grass. Grass, when it is dense and unbroken, provides an effective defence against surface erosion; but it affects the soil's porosity only along a comparatively thin layer, while the forest probes to a far greater depth. The grass cover (the more so because it easily becomes saturated) facilitates surface runoff, while the forest, when there has been no interference, tends to encourage infiltration and absorption by water and to increase underground supplies.

The forest is more than a defence against erosion. It is also a wonderful protection for the vegetal soil on the most sterile and the most unproductive areas, and it enhances their value. To destroy the forest or to replace it by some unsuitable form of land-working can have disastrous consequences for the productivity

[10] "The influence of forests on climate and water supply," *Forest Abstracts*, Volume 2, 1949.

of the soil. It increases the dangers of erosion. Many of the world's regions have mourned the results: the encroaching desert and the sandstorms and earth-storms which sweep over rich and fertile areas from the denuded lands.

Windbreaks and shelterbelts

One way of promoting soil productivity is through the bold use of windbreaks and shelterbelts. Forests cover those territories where climate (both temperature and humidity) favor their growth. The areas of the forest lands are enormous, and they largely coincide with the areas most suited to human settlement. To human intervention we owe two facts with most far-reaching effects: first, climax forests have been largely changed or modified by man with varying thoroughness. Secondly, over huge areas the forest has died away. It has given place to various postrecession crops and plants from bushes to scrub. It has become steppe or marshland. As a last stage, it has become desert.

If man had never interfered, there would not be to-day's profound difference between the world's potential forest and the actual forest areas. If man ceases to interfere, the forest can re-occupy all the lost ground which potentially belongs to it. It can evolve toward climax states and reach the stable equilibrium which is represented by the triad of climate, forest climax and climactic terrain. If ever this hypothetical situation is reached (and there are very few examples of it, even in zones least influenced by man), the climates of these immense land areas will be an aggregate of forest microclimates. Civilized man, however, lives in a profoundly modified world. The natural balance which the triad expresses is more or less severely undermined. All civilizations, in fact, have gone through an early phase in which man destroyed the forest. There always followed a later phase in which he tried to re-establish the forest and to defend it, for he had experienced the dire results of deforestation.

The forest still survives in lands populated by man. According to local conditions, it is more or less split up and alternates with tilled land; or else it predominates where agriculture is less profitable and where its protective role (on uplands, for example) is frankly acknowledged. In other parts the forest has disappeared and leaves no trace. The climatic changes which followed deforestation will have varied in their extent. Today's climate in a given region differs from its natural climate (that is, the forest climate) proportionately to the extent and severity of the deforestation.

Since the needs of the population now make it impossible to re-establish the forest over the whole of its potential growing area, we are faced with the problem: By what means can we (at least up to a point) recover the changed or destroyed natural balance? One of the most effective methods, it is now agreed, is the planting of windbreak belts as well as a general increase in tree-planting. This is just as true for highly productive and intensively cultivated land as it is for grazing land. By the use of treebelts we can extend the forest beyond the bounds of its normal growth-limits. We can extend it, for instance, into steppe-land. With plowing, irrigation, manuring and other aids we can enable trees to establish themselves in an environment which was by its nature hostile.

Some striking examples of the effects of windbreaks on the productivity of the croplands which they defend may be cited. Here, in fact, lies one of the chief reasons for advocating tree-planting on completely treeless land which it is intended to raise to a high productive level. Here trees are among the basic instruments for land reclamation. Incidentally, it is worthwhile to consider the part which trees outside the forest can play in the supply of timber. The production of timber is often an essential factor in the economy of the countryside as well as the towns. The financial yield from the timber of windbreak belts is a subject beyond the scope of this essay. None the less, it is well to remember how often the profit motive conditions a planting scheme.

Influence on Water Supplies

The problem of the influence of the forest on water supplies is treated at some length by Wilm.[11] It is not only vast and far-reaching in itself, but it is linked with the wider and more complex problem of the forest's influence on the system of water courses and eventually of catchment areas. One of the chief factors in the forest's effect on water systems is the soil's state of porosity and permeability. Any action which tends to decrease this natural porosity is (apart from its damaging effect on the forest's structure, vigor of growth and productivity) a big factor in the increase of run-off. To examples of man's harmful intervention we can add the removal of forest litter, the use of caterpillar tractors; and the sometimes unfortunate consequences of roadbuilding in the forest.

A warning, too, is needed on artificial lakes and reservoirs. They are often built without proper regard to the water system of the catchment area and the contributory upland basins. If these upland basins are not sufficiently clothed with trees (or at least with plants which provide a continuous cover) erosion can assume most serious proportions, especially where rainfall is very heavy. Many reservoirs have been rendered useless within a few years by sedimentation because no steps were taken to ensure soil conservation in the catchment area, especially by means of reforestation.

The improvement of catchment areas does not concern forestry experts alone. It draws upon a wider circle of experts, all of whom must act within the framework of a sound policy of land utilization.

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[11] Wilm, H. G. "The influence of forest vegetation on water and soil," *Unasylva*, Volume 11, Number 4.

Conifers of Mexico

Norberto Sanchez Mejorada
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FAO Technical Assistance Officer

The pines, firs and cypresses of Mexico and other genera of less importance have a potential value as exotics for planting programs comparable with that of eucalypts. They occur over a wide range of ecological conditions and present a diversity of characteristics and technological qualities.

The main causes of their diversity are the following:

1. They are found from 14° to 30° North latitude, i.e., on both sides of the Tropic of Cancer.
2. The altitude varies from about 800 to 3,500 meters with correspondingly large variations in average temperatures.
3. Annual precipitation varies with exposure from 600 to 2,000 millimeters.
4. The geological origin of the soils includes granites, lavas, volcanic ash, calcareous rocks and alluvial material and, according to the site conditions, has resulted in the formation of lateritic soils, prairie soils and even, it appears, true tchernozems. Very often, because of the geologic youth of the country, the soils have been only incompletely developed.
5. Frequent hybridization occurs, and probably also mutations (9).*

Botanists (8, 9) claim to distinguish 38 species and 25 varieties or forms of pines, but there is good reason to think (9) there are even others. There are also eight species and five varieties of *Abies*; six species and two varieties of *Cupressus*; four species and one variety of *Pseudotsuga*; 12 species and six varieties of *Juniperus*; one species each of *Taxodium*, *Picea* and *Libocedrus*.

Until now, only three or four species of pine and several species of cypress have aroused interest for planting programs. Obviously planters have hardly begun to draw on the enormous reserve of genera, species, varieties, races and genetic characters represented in the entire array of Mexican conifers. But much more needs to be known about them before they are likely to be widely acceptable. This paper only summarizes the general information already available.

* The numbers in parenthesis refer to titles given in the bibliography at the end of this paper.

Ecology

Distribution

Mexico extends on both sides of the Tropic of Cancer from latitude 15° to 32° North. It is estimated that only 5 to 7 percent of the land area, or about 100 to 150 thousand square kilometers are covered with true coniferous forest, but the actual area of distribution of conifers is much greater, extending over 500,000 square kilometers, or about a quarter of the country. This whole area was probably at one time covered by coniferous forests which were later cleared, burned or gradually destroyed by excessive cutting or grazing.

For the purpose of this paper, one may exclude the Peninsula of Yucatan, whose climate is tropical and where there are no conifers, and Lower California with a desert or dry Mediterranean climate. One can then divide Mexico into three natural zones, each extending from the extreme south to the extreme north of the country.

These are (see Figure 1):

1. The two coastal plains and the lower slopes of hill ranges up to about 800 meters in altitude, extending along the Pacific and the Gulf of Mexico. These two bands, one tropical and the other desert, bear no conifers.
2. The central plateau narrowing toward the south and with individual valleys south of Mexico City. This plateau carries little or no coniferous forest and is of practically no interest for this paper.
3. Between the two preceding bands or, in the south, between the two coastal plains, are regions of distorted relief, nearly always of volcanic origin, which coincide with the area of distribution of conifers. Altitudes vary from 800 meters to more than 5,500 meters (Orizaba peak 5,747 meters).

There are three main mountain chains, partially covered by coniferous forests:

1. western Sierra Madre, parallel to the west coast continuing to the Sierra Madre of the south and the Sierra de Chiapas;

FIGURE 1. – *Mexico: the situation of its coniferous forests.*

Courtesy, *Ecology*, *31* (4), 507-518, 1950.

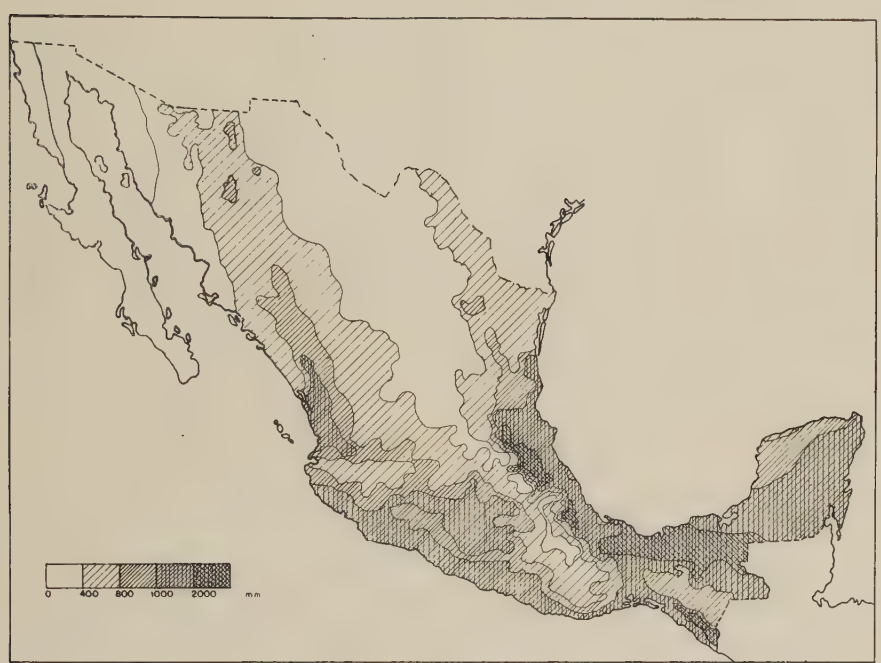

FIGURE 2. – *Mexico: its rainfall distribution.*

Courtesy, Servicio Meteorologico Mexicano

2. eastern Sierra Madre which continues as the Sierra of Oaxaca;
3. the neo-volcanic Cordillera, which cuts the central plateau from coast to coast, and produces forested mountain islets rising from plateau.

Precipitation

The tropical zone is usually described as being crowned with deserts, with a transition zone merging from moist to dry vegetation conditions. Mexico cannot, in general, be considered as a desert country. In fact, using as criteria to define deserts or more simply arid zones, an annual precipitation of less than 400 millimeters, a dry season of more than 6 months, or even the fact that agriculture is impossible without irrigation, then only in the northern and central parts of the Central Plateau, in the northern part of the Pacific coast area, and in Lower California, can true arid conditions be said to exist (see Figure 2).

Forest vegetation appears in areas with a minimum precipitation from 400 millimeters and conifers are found from a minimum of 600 millimeters. Figures 1 and 2, although schematic, give an idea of the relation between forests and rainfall.

The incidence of precipitation related to altitude is especially determined by exposure. This is illustrated in Figure 3. Exposure should be understood to be orientation in relation to the general direction of the prevailing winds which bear the moisture from the sea, i.e., from the east on the Atlantic slope and from

Table 1. - Variation of Precipitation Between Windward and Leeward Slopes

	Windward			Leeward		
	Station	Altitude, in m.	Precipitation, in mm.	Station	Altitude, in m.	Precipitation, in mm.
Atlantic	Jalapa	1 338	1 588	Perote	2 465	470
Pacific	Uruapan	1 610	1 674	Zamora	1 564	826

the west on the Pacific slope. On windward slopes there is produced the classic phenomenon of condensation, and on the leeward slopes the effect of *foehn* and of evaporation (Table 1).

This applies not only to the slopes which directly face the sea, but also to interior slopes, even though they are separated from the coast by other mountain chains. There are thus found " moist islets " covered with conifers in the middle of the central plateau and far from the two coastal Sierras.

The seasonal distribution of rainfall throughout the area is of the tropical type; one dry season of seven to eight months, except in the south where a second but short dry season occurs (curve III on Figure 4). This general distribution is illustrated in Figure 4. Total annual precipitation varies, of course (from about 600 to 2,000 millimeters in the coniferous forest), but 85 to 90 percent of this precipitation is concentrated in five rainy months from June to October and, in the north, in only four months.

The dry season is severe besides being long and this points up the great importance of the forest microclimate as in other countries with long dry seasons, both Mediterranean and tropical. The forest retains its own particular climate which is difficult to restore once the tree cover has been destroyed.

Temperatures

The mean annual temperature ranges between 10° and 24.5° C. over the area of distribution of conifers. Monthly mean temperatures vary only by 4° in the south to 8° in the north. However, the daily range is very great, varying from 10° to 20° C.

In Figure 5 the two heavy curves show recorded extremes of mean monthly temperatures. Between them are curves relating to other stations of the coniferous zones. Supplementary details in regard to the stations are given in Table 2.

Humidity

There is little recorded information for the forested areas because of the small number of meteorological stations. Using data from stations near the forests, as Durango in the north and Morelia in the central part of the country, it can be said that, during the six to seven dry months, humidity is low or very low. From 35 percent in April it goes up to 75 percent in July and August. Humidity increases as one approaches the slopes near the sea, particularly toward the windward side. On windward slopes in the zone of 2,400 to 3,000 meters, that is to say, where the firs occur, there is a zone of maximum humidity characterized by frequent mist.

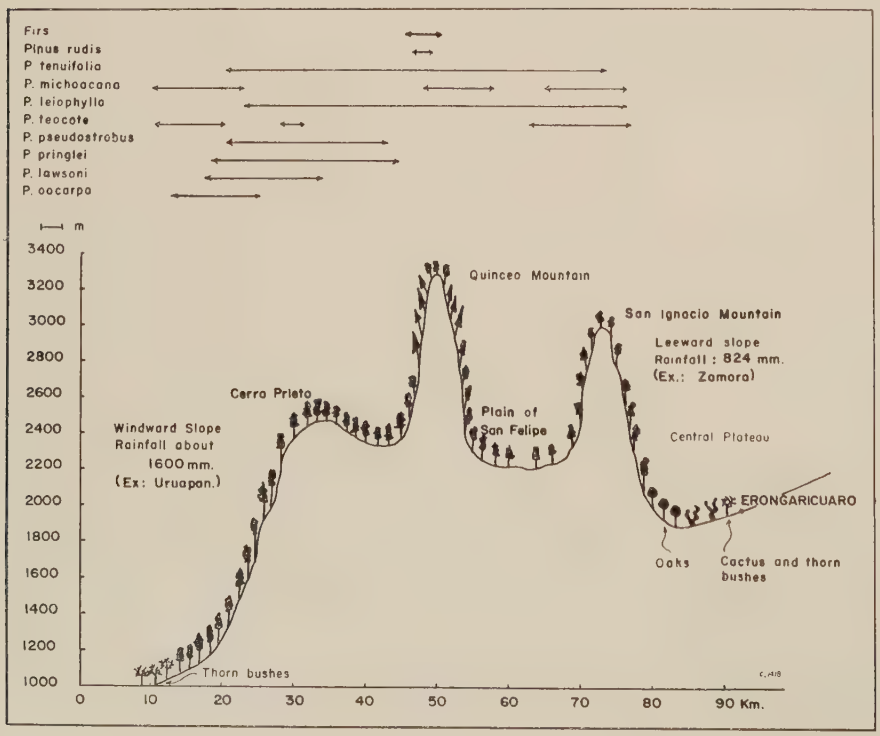

Figure 3. – *Distribution of pines and firs in the State of Michoacan, according to altitude and exposure.*

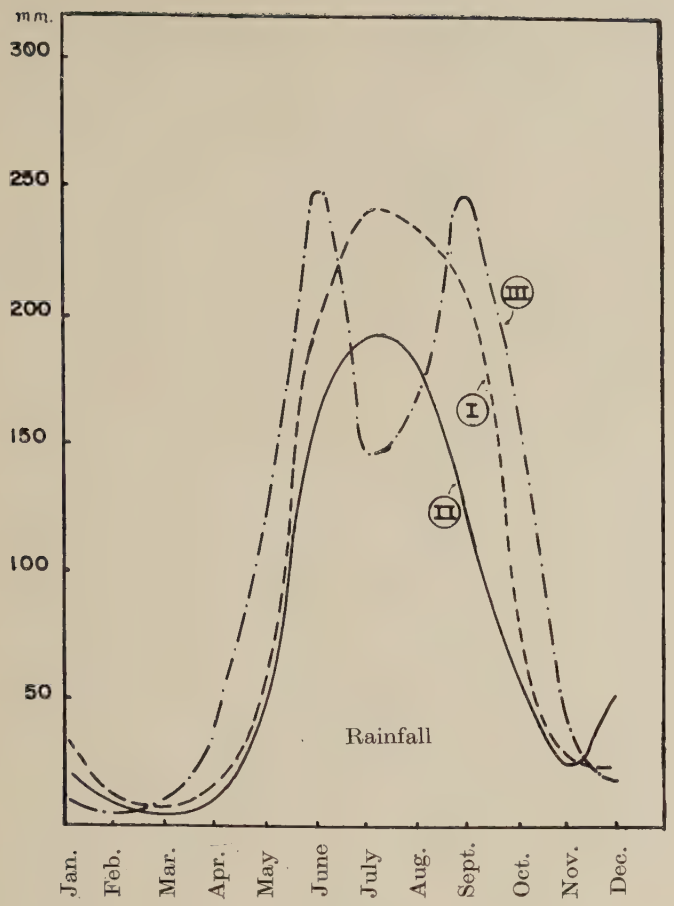

FIGURE 4. – *Rainfall variations.*

KEY

I *Patzcuaro*
II *El Salto*
III *San Cristobal de las Casas*

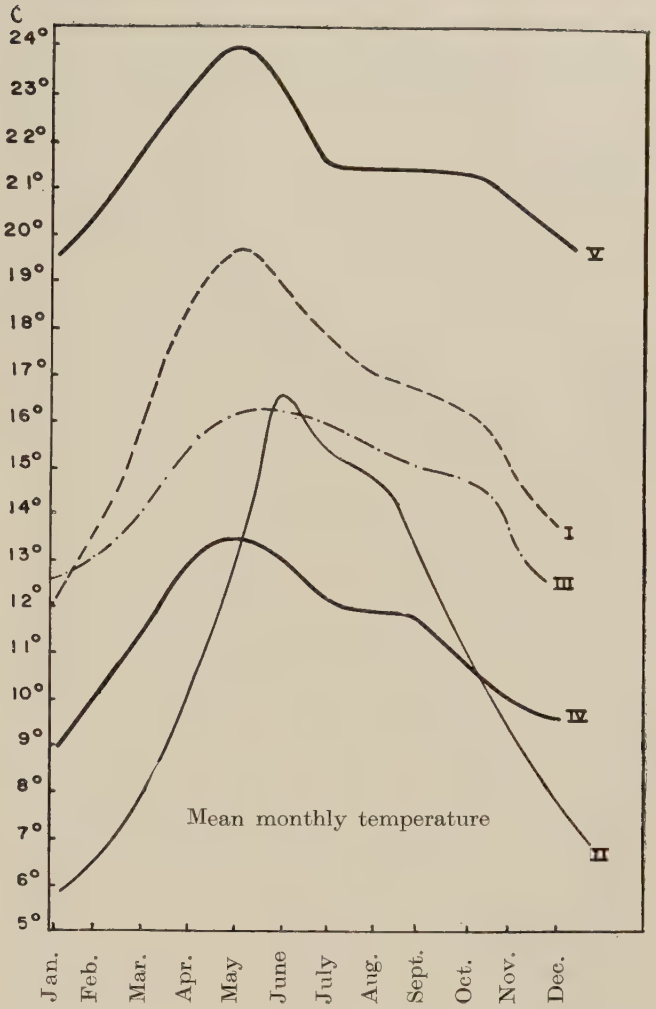

FIGURE 5. – *Temperature variations.*

KEY

I *Patzcuaro*
II *El Salto*
III *San Cristobal de las Casas*
IV *Desierto de los Leones*
V *Tacambaro*

Conclusion

The areas of the world where Mexican conifers can be suitably introduced must be mountainous and lie astride the Tropics of Cancer and Capricorn, receiving a minimum of 600 millimeters of rainfall annually, and perhaps high altitudes in the equatorial regions (Table 3).

This does not mean that other regions where the climate presents certain similarities with that of Mexico, for example, southwest France and parts of the Mediterranean Region, should not be interested in trying some carefully chosen Mexican conifers. Information on their adaptability is lacking, but other genera or species, for example, certain eucalypts, have been remarkably successful in climates quite different from that of their native habitat.

TABLE 2. – DETAILED INFORMATION CONCERNING FIVE FOREST STATIONS

No.*	Station		Latitude	Altitude, in m.	Total annual rainfall, in mm.	Absolute minimum temp. °C	Mean annual temp. °C	No. of days of rain
	Name	State						
I	Patzcuaro	Michoacan	19°31′	2 211	1 109	— 5	12.5	97
II	El Salto	Durango	23°46′	2 538	924	—15	11.4	74
III	San Cristobal de las Casas	Chiapas	16°44′	2 128	1 172	— 6	14.5	120
IV	Desierto de los Leones	Distrito Federal	19°17′	3 220	1 281	— 7.4	11.3	133
V	Tacambaro	Michoacan	19°12′	1 577	1 240	+ 3	21.5	109

* These numbers refer to the curves in Figures 4 and 5.

Table 3. – Areas Suitable for the Introduction of Mexican Pines

Hemisphere	America	Africa	Asia	Oceania
Northern	None	Cameroons Fouta Djalon, Guinea Uganda Ethiopia	India Burma Thailand Viet-Nam	
Southern	Southern Peru Bolivia Ecuador Northern Argentina Northern Chile	Northeastern parts of Union of South Africa Northern and southern Rhodesia Tanganyika Mozambique Madagascar		Australian Alps (Tropical zones)

Geology and Soils

Pines occur on soil over a substratum of all kind of geological formations including volcanic rocks such as the andesites and basalts, schists, and sedimentary rocks such as limestone and sandstone. Rather than the parent rock, it is the differences in evolution of the soils resulting from the effects of weathering, fire or destruction of forest cover, that is important. Pine is found on lateritic soils with iron concretions, as well as on soils derived from limestone and from basalt. There exist also many almost virgin soils of recent volcanic origin where pines have become successfully established. This is especially true on volcanic ash and lava.

Pines are found at altitudes of 800 to about 2,200 meters on yellow or red lateritic soil. The evolution of this soil depends on its exposure, and degree and date of the clearing of the forest. At higher elevations there occur black prairie soils and typical podzols and even tchernozems at elevations of 2,300 to 3,000 meters. In the zone of podzols where the coniferous forest has not been too much affected, and where there is a mixture with hardwoods, there are found brown forest soils without well-differentiated horizons under the humus layer. These are the soils which grow the best forests, and it seems that the climax is a mixture of hardwoods and conifers.

Additional information on the distribution of pines and other conifers in relation to the soil is given later in this paper.

Human Action

Shifting cultivation with the burning of the forest has been practiced throughout Mexico since antiquity. Fire was the instrument of the hunter, and after the Spaniards had introduced cattle, was used as a primitive method to favor the growth of green grass at the end of the dry season. Fire generally passes over all the pine forest at intervals of less than five years. It affects the fir forest less except on their edges because of the higher humidity.

The burning of the forests under the practice of shifting cultivation on long rotation of 10 to 15 years and on parcels of only 2 to 3 hectares permits the re-establishment of even-aged pine forest from the seed of surrounding trees. But in the zones of great density of population, as in the States of Michoacan, Jalisco, Mexico, Puebla and Hidalgo, nomadic agriculture is no longer practiced and burning ends in permanent clearing which may extend to hundreds of hectares.

The remaining areas accidentally burned or fired for grazing have a park-like appearance with no young growth. It is in the mountainous zones of low population density, as in the States of Oaxaca, Guerrero, Durango, Chihuahua and certain regions of Michoacan or where by some miracle fires are less frequent, where there are found relatively dense forests with a rather well-formed understory of deciduous species and with a good distribution of age and diameter classes.

Fortunately in the coniferous forests, fire does not destroy whole trees as is the case in the Mediterranean type forests which contain a highly inflammable undergrowth. Grass fires appear to affect only young pines below 5 or 6 meters in height. Nevertheless, fire always has other harmful consequences such as soil degradation, weakening of the trees left standing and destruction of the moist humid microclimate. However, it seems that five years of complete protection against fire are usually sufficient for the establishment of a lower story of young pines and various species of shrubs and plants.

Commercial exploitation is often blamed in Mexico for forest destruction. It appears rather that this has been due either to clearing for cultivation, or to a combination of heavy cutting and uncontrolled fires afterwards which destroy all young seedlings. Grazing, except by goats, does not in itself seem to affect the coniferous forests seriously, but it is indirectly dangerous as the reason for fires started by shepherds.

Of the 10 to 15 million hectares of conifer forests which now exist in Mexico, it is estimated that three million hectares in the States of Chihuahua, Durango, Michoacan, Guerrero and Oaxaca, have not yet been systematically exploited, but they have been subject to clearing, fire and grazing. The fir forests, considered less valuable for lumber, are extensive only in the central region at the higher elevations and have only been affected in the vicinity of villages and settlement centers; in the states of the north, they cover only small

areas, in mixture with *Pseudotsuga* and with the very rare *Picea chihuahuana* on northern exposures or in cool moist ravines.

Associated Vegetation

The pine is practically the only conifer which occurs below about 2,400 meters elevation. Above that the fir begins and there is found a transition forest type composed of pine, fir and sometimes cypress in varying proportions. Then, up to about 3,100 meters, fir and sometimes cypress are the only conifers. From 3,100 to 3,500 meters elevation there are again found pines succeeded by alpine meadows. Permanent snows occur at the top of three or four very high peaks. (Figure 6).

The pine forest up to about 2,400 meters is certainly never the climax type. As in the southern United States, complete protection against fire would probably bring about a return toward a climax of hardwoods. In those forests which are relatively well protected against fire, one finds a great abundance of hardwood species (Figures 7 and 8) comprising:

1. at all altitudes, a large number of species of oaks which are not yet well known;
2. at the lower altitudes in the subtropical zones, spiny species such as *Prosopis juliflora*, *Acacia farnesia* and other acacias: these occur on the dry leeward slopes already mentioned, and are joined here by *Arbutus* sp.;
3. at higher elevations, alders are found in the moister zones.

In cool ravines, naturally protected against fires and where pine is almost totally absent, there is found a flora rich in such deciduous species as hornbeam, oaks and basswood (lime). These ravines are moist, receive little sunlight, and their vegetation is completely different from that of the pine forest.

In addition to the trees or shrubs already mentioned, cactus occurs at low altitudes on leeward slopes and at higher altitudes, *Solanum madrense*, *Senecio salignus*, *Verbesina montanaefolia*, *Baccharis conferta* under which the fir seedlings establish themselves, and a legume *Lupinus hartwegii* important for covering denuded land and for the formation of a forest microclimate.

As has been said, the greater the frequency of fire the more the pine forest resembles parkland, with several ferns such as *Pteridium aquilinum* (indicating soil acidity), grasses, and scattered oaks and a much reduced organic soil cover.

The better the soil, the less open is the forest. Other things being equal, such as climate, exposure and slope of the ground, the better preserved forests occur on brown soils, on brown lateritic or even yellow soils, or on black soil at appropriate altitudes. The forest most adversely affected by fire are those growing on red lateritic, sometimes very eroded, soils.

Soil types	*Species*
Red soils of the lateritic or iron bearing soil type:	*Pinus oocarpa*, *P. michoacana*
Black prairie soils or tchernozem:	*Abies* sp., *P. rudis*, *P. hartwegii*, *Cupressus* sp.
Sandy or rocky soils:	*P. lumholtzii*, *P. durangensis* (in Central Mexico), *P. teocote*
Brown forest soils:	*P. montezumae*, *P. pseudostrobus*, *P. tenuifolia*, *P. patula*, *P. durangensis* (in the north), *P. cooperi*
On clearings:	*P. leiophylla*, *P. pseudostrobus*

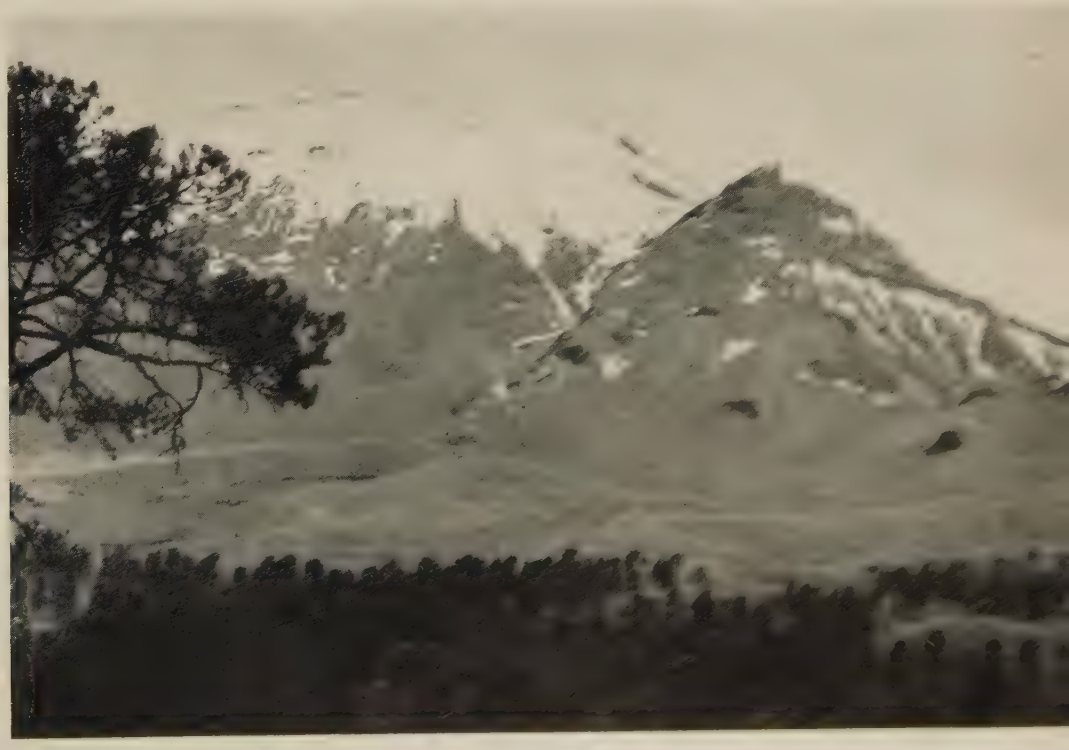

Figure 6. – *Eternal snows, alpine grass and pines* (Pinus rudia *and* P. hartwegii) *at 3,500 to 5,000 meters.*

FIGURE 7. – *Old second-growth forest, partially protected against fire, in the State of Michoacan.*

FIGURE 8. – *Virgin forest in the State of Durango, with* Pinus ponderosa. *Here there is a well-established understory.*

GENETICS

The current classification of the various genera, species, and principal varieties of Mexican conifers, has been developed by Professor Maximino Martínez of the Institute of Biology of the University of Mexico. For the pines, this classification is based on the character of the needles and the cones, on the presence or absence of wings on the seeds, and on the persistence of the bracts which surround the needle clusters. The reader is referred to two basic books by this eminent botanist (8).

N. T. Mirov (9), who has studied the composition of resin of the various Mexican pines, considers that there are certainly other species than those indicated by Martínez. It has been noted that the pines of the central and southern parts of the country present a greater variability in their botanical characteristics than those of the pines in the northern states such as Durango and Chihuahua. The reason for this is not clearly understood.

The Mexican conifers and especially the pines are of considerable interest to geneticists. There is already growing at Placerville, California, an interesting hybrid of *Pinus ponderosa* and *P. montezumae* (9). In the natural forests, the following hybrids have been noted: *Pinus montezumae* × *P. michoacana*, *P. montezumae* × *P. pseudostrobus*, and there certainly exist others in the transition zones of the central states at elevations between 1,500 and 2,000 meters where at least six or seven different species of pine occur on the same hectare.

SILVICULTURE

The silvical characteristics of the Mexican conifers are similar to those of all pines and firs and, for this reason, only a few general remarks are given here.

As in the case of other pines, the Mexican pines are pioneer species, strong light demanders which invade bare land, mineral soils, and openings in the forests. Nevertheless, in forests having an abundant undergrowth with adequate protection against fire, sufficient young plants get away to assure adequate natural regeneration. This is fortunate, because it does not appear to be advisable to use clear-cutting practices in the pine forests as it leaves the soil too exposed to the tropical climate.

The firs are tolerant to shade, and in fact require shade during their early years. However, they appear better adapted to light than the firs of Europe, and resemble in this regard the Mediterranean firs. They come in on bare soil under brushy cover such as *Baccharis conferta*, or in natural or artificial openings in the forest.

Cypress appears to have characteristics similar to those of the fir.

STAND COMPOSITION AND VOLUME

The coniferous forests of Mexico are in general irregular as regards distribution of diameter classes, if not from the standpoint of age. This is normal in old growth forests, but is also the case in second growth

Table 4. – Preliminary Classification of the Principal Mexican Conifers according to their Requirements in Altitude and Temperature

Climate	Mean annual temperature, in °C.	Approximate altitude, in meters	Species
Tropical	Over 24	Below 900 (exceptionally)	*Pinus strobus* var. *chiapensis*, *P. oocarpa* *
Subtropical	19–24	900–1,650	*P. douglasiana* (s), *P. herrerai*, *P. lawsoni*, *P. leiophylla*,* *P. michoacana*, *P. montezumae*, and varieties, *P. oocarpa*,* *P. pringlei*, *P. pseudostrobus*, *P. strobus* var. *chiapensis*, *P. tenuifolia*
Warm temperate	17–19	1,650–2,000	*P. douglasiana*, *P. herrerai*, *P. lawsoni*, *P. ayacahuite*, *P. ayacahuite* var. *veitchii*, *P. leiophylla*, *P. lumholtzii*,* *P. michoacana*, and varieties, *P. montezumae* var. *lindleyi*, *P. oocarpa*, *P. patula*, *P. pringlei*, *P. pseudostrobus*, *P. tenuifolia*, *P. teocote*, *Juniperus* sp. * *Taxodium mucronatum* (Swampy soils and riverain soils)
Temperate	10–17	2,000–3,100	*P. arizonica*,* *P. ayacahuite* var. *brachyptera*, *P. cambroides*,* *P. chihuahuana*,* *P. duranguensis*,* *P. engelmanni*,* *P. flexilis*, *P. greggii*,* *P. hartwegii*, *P. leiophylla** *P*, *lumholtzii*,* *P. cooperi*, *P. michoacana* and varieties, *P. montezumae*, *P. nelsoni*,* *P. oocarpa* var. *trifoliata*,* *P. patula*, *P. pinceana*,* *P. pseudostrobus*, *P. rudis*, *P. teocote*, *Taxodium mucronatum* *Juniperus* sp.* from 2,400–3,100 m. or on cold wet north exposures: *Abies* sp., *Pseudotsuga* sp. and *Cupressus* sp.
Cold temperate	less than 10	over 3,100	*P. hartwegii*, *P. rudis*

* Indicates species which are able to adapt themselves to dryness, i.e., less than 1,000 mm. precipitation per year.

forests as a result of the official regulations controlling forest exploitation which forbid clear-cutting and restrict fellings to not more than 35 to 40 percent of the standing volume. The forests coming in on clearings are certainly even-aged but, because of the wide differences in rates of growth of species and of individuals, they already take on the aspect of uneven-aged forests after a few years.

Fir forests and the cypress forests are all uneven-aged.

The structure of almost all types of forests is represented by the diagram in Figure 9.

The pines and firs do attain diameter of 1.2 meters including bark, and heights of 50 meters. However, in the old growth forests, the average diameter of the larger trees is 80 centimeters and they may grow to 300 years of age. In second growth forests, the greater part of the growing stock falls into the 40 to 50 centimeters diameter class.

Standing volumes of growing stock vary considerably. They may attain 600 cubic meters per hectare in old growth forests, 300 cubic meters in second growth forests already exploited in the central zones, down to as low as 50 cubic meters. For all of Mexico, an average of 80 cubic meters per hectare applied to 10 million hectares of conifers, gives an estimate of total standing volume of 800 million cubic meters, of which 95 percent is pine.

GROWTH

Almost all commercial exploitation is still carried out in old growth forests. Only rarely is there cutting in second growth forests, apart, of course, from the very frequent unauthorized cutting by the rural population to meet their domestic needs.

Virgin forests or old second growth forests

In the virgin forests, although the standing volume is high, the rate of growth is low, 1 to 2 percent according to climatic and soil conditions, and there is an equilibrium between growth and natural mortality. In old second growth forests, where the older trees have been once removed, the growth rate varies from 3 to 5 percent according to site conditions and exceeds natural losses.

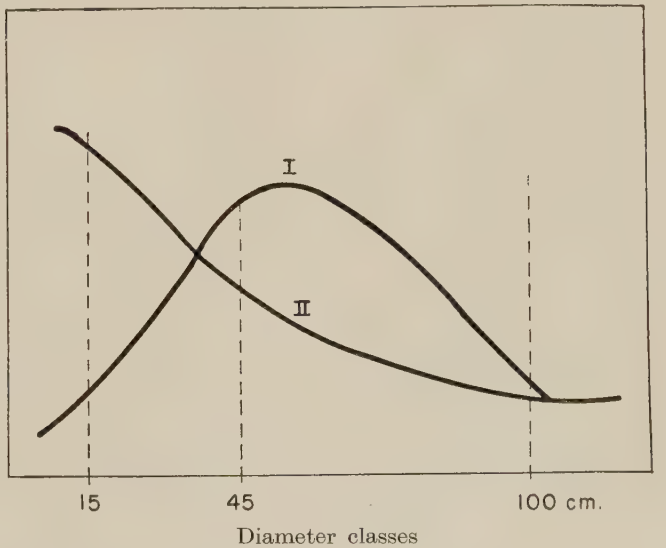

Figure 9. – *Relationship between the volume and number of trees in the various diameter classes.*

Key

I *Volume*

II *Number of trees.*

Recently exploited forest

There is very little information for the relatively dry forests in the northern states which grow more slowly than the forests of the southern and central zones. For these latter zones, the following growth rates have been recorded from sample areas:

Standing volume m^3 *per ha.*	*Growth rate* *percent*	*Observations*
107	6.40	Black or brown soil
76	4.95	"
168	3.34	"
122	6.30	"
137	2.92	Climate-leeward
149	3.90	Climate-windward
123	5.40	"
137	2.90	Red lateritic soils
96	4.25	"
89	2.40	"

The data shown above relate to forests dominated by *Pinus montezumae*, *P. tenuifolia*, *P. pseudostrobus*, *P. leiophylla*, *P. michoacana*.

The effect of cutting on growth is illustrated by the following data relating to a pine forest of 127 hectares protected against fire in the State of Jalisco, at latitude 19° N., on yellow lateritic soils. The four dominant species are *Pinus douglasiana*, *P. oocarpa*, *P. michoacana*, *P. tenuifolia*, growing in a relatively moist climate with about 1,500 millimeters of precipitation.

Table 5. – Effect of Cutting on Growth

	Before cutting	After cutting	10 years after cutting
	..... *in cubic meters*		
Standing volume	127	86	176
	..... *percent*		
Average rate of growth	4.4		7.6

Thus, cutting out the trees of more than 45 centimeters in diameter, clearly had a beneficial effect on the remaining growing stock. This has been confirmed in other forests by many borings made by the authors using a Pressler borer. In other words, the pines of Mexico growing below the latitude 19°, under relatively favorable conditions, respond well to even elementary silvicultural practices. Information is lacking about the pines of the cooler and drier northern states of Mexico, but they are of much less interest for use as introduced species than are the pines from the central and southern part of the country.

Artificial Plantations

Mexico

There has been little artificial planting of indigenous pines or other conifers in Mexico itself, because there is plenty of natural forest, natural regeneration is easy and establishing new plantations in areas with long dry seasons is difficult. The total area of plantations in the entire country is probably less than 500 hectares.

The most interesting plantation is north of Mexico City in the *Desierto de los Leones*. The elevation and climate of this station are indicated in a previous Table and correspond to curve IV in Figure 5. The conditions are favorable, the soils are deep and of good quality, approaching that of brown forest soil. About 150 hectares have been planted on land formerly occupied by forest and since denuded. The plantations were begun in 1920 with *Pinus patula* and *P. montezumae*. At the time of planting, there existed the remnants of the natural fir forest. Now, after 38 years and numerous thinnings, there is an average per hectare of 170 cubic meters of fir, and 260 cubic meters of pine with an annual growth rate of 6 percent (10.5 cubic meters per hectare) and 9 percent (23.5 cubic meters per hectare) respectively. The plantations were established with 1-year-old bare-rooted nursery stock.

Other countries

Mexican pines and cypress have been planted on a small scale in many parts of the world (see *Unasylva*, Volume 12, Number 3, page 121). In the Union of South Africa, large-scale plantings of these species have been made. The climate and altitudes are very similar to those of Mexico.

In South Africa, there are extensive plantations (1, 6, 7, 12, 14) of *Pinus patula* and certain areas of *P. pseudostrobus*, *P. leiophylla* and *Cupressus lindleyi*. The South African foresters would prefer to develop *P. pseudostrobus* because of its better wood quality, but due to the difficulty of obtaining seed, they have developed *P. patula* from seed obtained from existing plantations.

The seedlings are raised from seed sown in furrows and transplanted in the nursery. They are planted with bare roots at square spacing varying from 2 to 2.75 meters on land which has been previously cleared of brush and plowed. Pruning and thinnings are practiced. The yields reported are excellent, an annual average of 10 to 22 cubic meters per hectare for 30-year-old plantations. Average annual diameter growth exceeds 1 centimeter and height growth, 1 meter. Under favorable conditions there is an average increment of 32 cubic meters per hectare annually.

In Madagascar (16), the yields from *P. patula* are excellent. The methods of planting are similar to those used in South Africa but before planting roots are coated with clay and fertilizer.

These examples show that, at least for two of the Mexican pine species, remarkable results can be obtained. That other species can grow equally well is indicated by the results of natural forests in Mexico itself where no special silviculture treatment has been accorded other than protection from fire. The conifers thus seem to hold considerable promise for introduction to areas of comparable conditions.

Table 6. – Climatic Requirements of Pinus patula

Area	Latitude	Annual average temp., in °C.	Annual precipitation, in mm.
1. Zone of distribution of *P. patula* in Mexico	19°N.	12–20	1 000–2 000
2. Plantations of *P. patula* in South Africa	23–29°N.	13–22.5	700–1 900
3. Madagascar	21°S.	22.5	1 739

Pathology

It is surprising that the Mexican pines, which are so frequently subject to fire and excessive tapping for resin, do not suffer more severely from pests and diseases. There are many potentially noxious insects or fungi but it appears that only one is dangerous. This is a species of *Dendroctonus*, the larvae of which excavate galleries in the sapwood which leads to the death of the tree. It attacks especially *Pinus leiophylla* and sometimes *P. montezumae* but rarely other species. It is sometimes followed by *Ips* (10) which is only a secondary agent. Generally the damage does not affect more than a few hectares and the incidence of severe attack can be ascribed to drought, intense insolation and exposure, and to fires, or in a word to all of the external causes which weaken trees and affect their growing conditions (15). It is known that a tree which has been attacked can eliminate the larvae if it is capable of secreting sufficient resin.

There are preventive methods but once an attack has started, the only cure is to fell the attacked trees and carefully burn all of the bark, branches and other debris.

Pine defoliators of the family *Lasiocampides* do not seem serious: these include *Coloradia pandora* in the north and *Neodiprion* sp. in the central region (11).

Technology

No systematic study has yet apparently been made of the mechanical properties of the wood of Mexican conifers. They can be summarily divided into two classes:

1. The lightest, such as *Pinus engelmanni*, *P. duranguensis*, *P. montezumae*, *P. pseudostrobus*, *P. tenuifolia*, *P. patula* and *Cupressus* spp., have a specific gravity of less than 0.45. They resemble the American *P. ponderosa* and are suitable for manufacture of panels and moldings, light construction, containers, and in general for all uses where strength is not a primary factor.

2. The heavier species, whose specific gravity exceeds 0.45 and sometimes even 0.50 (some are not floatable), include *Pinus oocarpa*, *P. michoacana*, *P. lawsoni*. They are of a subtropical type and resemble the "pitch-pines" of the southern United States. These are suitable for heavy and light construction, dock works, flooring, and in general for those uses where strength is an important factor.

The above is apparently confirmed by technological studies made in South Africa on plantation-grown Mexican pines (12).

With regard to wood quality it can be said that, in general, except for certain species like *Pinus oocarpa* and *P. leiophylla*, trees growing close together are self pruning, and from old forests it is common to obtain 20 percent clear lumber from logs over 50 centimeters in diameter. Many species are used for veneer: *Pinus engelmanni*, *P. duranguensis*, *P. pseudostrobus*, *Pinus tenuifolia*.

It seems then that the whole range of Mexican pines present a gamut of technological qualities, which make them suitable for very many uses, but more research is still needed on properties. Then those species could be selected, for introduction as exotics, best suited for the required end-use.

There is fortunately more information available on the utilization of Mexican pines and firs for the manufacture of chemical and mechanical pulp, and paper.

Four mills scattered through the coniferous zones manufacture sulphate pulp and kraft paper from a mixture of pine and small proportion of cypress. The more common pines are used and their products have qualities at least equal to those of imported products.

An unpublished study (13) shows that mechanical pulp and newsprint prepared from pines, with 15 to 20 percent of semibleached pine pulp, has the same characteristics as the equivalent products made from pines of the southern United States, where four large paper mills are manufacturing newsprint. In Mexico itself, a newsprint mill is being constructed and another is planned. These will use more than 15 different pines which have already been successfully tested in the laboratory and in the mill.

Another important use of Mexican pines is for the production of resin in the States of Michoacan, Jalisco and Mexico. The simplified French method of tapping is used and the annual production is over 33,000 tons of gum. The species which are most productive include *Pinus leiophylla*, *P. lawsoni*, *P. pringlei*, *P. teocote*, *P. michoacana*, *P. oocarpa*, all of subtropical character. Each tree produces 1 to 4 kilograms of gum per year and the yield per tree is greater as the climate is warmer and the forest more open.

As in the southern United States the stumps of certain pines of the subtropical type are distilled to produce pine oil. Such a distillation plant has just been constructed in the central region.

FIGURE 10. – *Composite photograph showing land use in the topography of the central region of Mexico, that is, in the State of Michoacan. The mountains are forested and the valleys cultivated.*

POSSIBILITIES FOR SEED COLLECTION AND EXPORT

At the end of the last century, Mexican pines were introduced into South Africa. Since the beginning of this century, different countries have tried different Mexican conifers from seed sent from Mexico. In general, however, the supply made available was inadequate and not satisfactory in quality. Often the seeds received were of species different from what the labels indicated.

For this reason, the Forestry Department of the Union of South Africa sent Mr. E. E. M. Loock, author of *The Pines of Mexico and British Honduras* (7), to Mexico in 1947/48 to collect seed of known origin and authenticity. Due to many difficulties Loock was only able to collect in one year 158 kilograms of seed, principally of *Pinus pseudostrobus*.

Since that time Mexican organizations, and since 1951 officers of FAO who have worked in Mexico, have only been able to fill requests for seed in a most inadequate manner. There is no commercial organization for seed collection: several forestry enterprises collect seed of pine or firs for use in their own restricted planting work, but usually not of the species requested by other countries.

The authors, during their inventory of 300,000 hectares of coniferous forests in the State of Michoacan (see Figure 10 and *Unasylva*, Volume 12, Number 2), began in 1953 to organize on a modest scale the collection and shipping abroad of certified seeds. During the past four years about 40 to 50 kilograms of seed have been sent each year to a number of countries including the Rhodesias, Tanganyika, Cameroons, Madagascar, Nyasaland, Colombia, Paraguay, New Zealand, Australia, and the Belgian Congo. The species most often sent were not the most often demanded, but had to be limited to those which could be found in the area under reconnaissance. These include *Pinus pseudostrobus*, *P. tenuifolia*, *P. oocarpa*, *P. michoacana* and *P. montezumae*.

For the moment it is difficult to extend this activity for lack of time, capital and means. In order to satisfy all requests and to guarantee the origin and quality of seeds, a special organization with certain resources at its disposal would be indispensable for the following reasons:

1. The large number of species, varieties or races which would require close supervision during collection.
2. The distance between the zones of collection and their relative inaccessibility. These zones are scattered for more than 2,000 kilometers from north to south and 600 kilometers from east to west, requiring much rough travel.
3. A great variation in ecological conditions within short distances.
4. The irregularity of seeding. It is estimated that for each species there is one good seed year each five years. This involves the necessity of having available an establishment not only for extraction and cleaning of seeds, but also for proper storage in a cold chamber.

It is hoped that over the next few years it will be possible to find the resources to establish such an organization.

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FORTHCOMING MEETINGS

1960

Fifth World Forestry Congress, Seattle, Washington, U.S.A.	*25 August - 16 September*
(Executive Secretary: Dr I.T. Haig, Executive Secretary, Organizing Committee, Fifth World Forestry Congress, Department of State, Washington 25, D.C.)	
Far East Pulp and Paper Conference, Tokyo, Japan	*October or November*
Asia-Pacific Forestry Commission, India	*February*
Latin-American Forestry Commission	*September or October*
Near East Forestry Commission	*November or December*

1961

Second World Eucalyptus Conference, Brazil

International Consultation on Plywood

European Forestry Commission

Bamboo Silviculture

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Throughout wide areas of the world, bamboos serve a multitude of purposes. Rural housing largely depends on them. Pulp and paper manufacture from bamboos is expanding. A monograph on bamboos is in preparation by FAO, but this article is a modified extract from the general volume entitled Tropical Silviculture *recently published by the Organization. It deals summarily with the occurrence of bamboos; physical factors of climate and soil, silvical factors, growth habits, and silvicultural practices, as developed largely in Asia and to a lesser extent in Latin America and Africa.*

Bamboo is one of the gregarious associations which occur in moist deciduous and dry deciduous forest, as well as in wet evergreen forest. To consider its silvicultural treatment only as an understory in these forests would hardly do justice to a family which is not only widespread throughout the tropical and subtropical (and even temperate) parts of the world but which has such tremendous importance in the everyday life of so many millions of people. In many parts of the tropics and particularly in Asia, bamboo is considered, next to rice, as the staff of life. To list its almost infinite uses would be to give a catalogue of practically every human need, even food in the form of fresh or preserved young shoots. It is used in the construction of houses, bridges, furniture, fishing poles, water pipes, weapons, bags, baskets, cloth, reinforcement of concrete, and paper manufacture.

Occurrence

All the continents except Europe have native bamboos. The 60 genera of *Bambuseae*, estimated to comprise more than 500 species, belong to the same family, Graminae, as corn, wheat, oats, barley and other grasses. They are woody perennials varying in height from 6 inches (15 centimeters) to over 100 feet (30 meters) at maturity. They occur principally in the tropics and in mild climates, although some species occur naturally in China, Japan, Chile, and in the United States, under temperate conditions. The genus *Bambusa* has the largest number of species, most of which are native to Africa, China, India and Japan.

Good (1953) notes that: "Unless the somewhat doubtful American species are correctly associated with the Asiatic species of *Bambusa*, only the more or less pantropical genus *Arundinaria* is found in both the Old and New Worlds. *Oxytenanthera* occurs in Africa and Asia; *Schizostachyum* in Madagascar, Asia and some of the Pacific islands including Hawaii; and *Cephalostachyum* and *Ochlandra* both in Madagascar and Asia. No other genus occurs in more than one sector of the tropics and some are quite narrowly distributed. It has been calculated that 90 percent or more of the 500 species are either Asiatic or American, the former being much more numerous than the latter. The representation of the bamboos in tropical Africa is remarkably small and (this is) one of their most striking features, consisting of only about 6 genera and 14 species, which is much less even than that of Madagascar, where there are 9 genera and perhaps 30 species."

Bamboos are an important component of wet evergreen, moist deciduous and dry deciduous forests in the tropical parts of southeastern Asia, principally in the Andamans, in Burma, Cambodia, Ceylon, India, Indonesia, Laos, Malaya, New Guinea, Pakistan, Philippines, Thailand and Viet-Nam. Genera found in these countries include *Arundinaria*, *Bambusa*, *Thyrsostachys*, *Gigantochloa*, *Oxytenanthera*, *Dendrocalamus*, *Cephalostachyum* and *Melocanna*. At higher altitudes and in temperate climates in Asia, as in Bhutan, China, Japan and Nepal, many of these genera are represented by different species, and other genera such as *Phyllostachys* and *Sasa* are common in China and Japan. In this connection, it is interesting to note that pure bamboo forests are common on slopes where shifting cultivation has been carried on in Burma, East Pakistan and other parts of Asia. In tropical parts of Africa, two indigenous bamboos occur, *Oxytenanthera abyssinica* in dry deciduous formations, and *Arundinaria alpina* in the humid highlands of the equatorial zone.

In Latin America, the genus *Guadua* is most important; *G. angustifolia* in Colombia and Ecuador, *G. amplexifolia* from Venezuela north to Nicaragua and Honduras, *G. inermis* in Mexico and *G. superba* in Brazil. The *Guadua* species are considered as indicators of good land for conversion into banana plantations. At the higher altitudes and in temperate climates of Latin America, the genus *Chusquea* is of consequence. Two species, *Arundinaria gigantea* and *A. tecta*, are the only native bamboos in the United States of America (McClure 1952a).

The cultivation of bamboos has meant the introduction of many exotic species in numerous countries. Thus, for example, in Argentina, *Phyllostachys aurea*, *P. bambusoides*, *P. nigra*, *Bambusa tuldoides* and *B. vulgaris* have assumed economic importance, and a number of others are used as ornamentals. *B. vulgaris* is the species most widely cultivated in the tropics of the

Western Hemisphere, and has even replaced the native *Guadua* species, as in Guatemala and Nicaragua. This *Bambusa* has become established in Jamaica as a result of sprouting from stakes used in shifting cultivation of yams and other crops on steep hillsides. It is also common in Puerto Rico. *B. tuldoides* was introduced in Brazil from China over 100 years ago, often as hedges and farm boundary markers. Similarly, *Phyllostachys aurea* was brought into many parts of Latin America from China, and is probably the most common exotic bamboo next to *Bambusa vulgaris*. In China and Japan, many of the native species are also cultivated successfully.

Physical Factors

Climate

The majority of bamboos thrive at temperature ranges of 48°F. to 97°F. (8.8° C. to 36° C.). Some species, however, grow at high altitudes, as in the case of some *Arundinaria* species up to 10,000 feet (3,050 meters) in India and up to 12,000 feet (3,650 meters) in Latin America, or in regions where frosts and snow are common, as *Chusquea* in Chile. Rainfall is an important factor, and 40 inches (1,020 millimeters) seems to mark the minimum annual precipitation required. The upper limit is not known but bamboos are found in zones with over 250 inches (6,350 millimeters).

The most common range is 50 to 160 inches (1,270 to 4,050 millimeters) per year. Relative humidity is correspondingly high and ranges from 80 percent upward. The distribution of the rainfall in Asia is affected by the southwest and northeast monsoons, which are often accompanied by strong winds but these do not seem to act as limiting factors to occurrence or growth.

Soil

Most bamboos are found on sandy loam to loamy clay soils, derived from river alluvium or frequently from the underlying rock. Yellow, brownish yellow, or light reddish yellow are the soil colors most frequently encountered. Humus may produce a bluish color. Subsoils vary from light red to yellow to bluish gray, and in some areas contain manganiferous iron and ferruginous concretions. Usually bamboo prefers well-drained soils but it is also found on swampy or wet stream beds. No bamboo is reported on saline soils. Individual species have well-defined habitats and for this reason may be taken as indicators of different forest types. For example, *Bambusa polymorpha* in Burma requires a moist, fertile, well-drained soil characteristic of the moist upper mixed deciduous forest. *Dendrocalamus strictus*, on the other hand, is associated with the drier forest types; and *Cephalostachyum pergracile* is intermediate between the drier and moister sites. *Bambusa tulda* occurs on stream bed alluvial flats; *Oxytenanthera albociliata* on low plateaus or hills on sandy or lateritic soils; *Dendrocalamus longispathus*

Figure 1. – *A clump of* Cephalostachyum pergracile - tinwa *bamboos in flower.*

Courtesy, Insein Division, Burma

on edges of damp ravines; and *Teinostachyum helferi* in the dampest valleys in evergreen forests. Under Indian conditions (Deogun, 1936; Sen Gupta, 1952), *Dendrocalamus strictus* does well in open, mixed deciduous forest or in open areas on stony hillside soils, and extends into drier conditions than any other bamboo. *Bambusa arundinacea* occurs on rich moist soil such as alluvial stretches along streams.

Silvical Factors

Composition

Pure bamboo forests are found singly or in compact or open clumps, but usually bamboo forms the understory of the evergreen, semi-evergreen, moist deciduous and dry deciduous forests of tropical areas. In most cases this understory consists of a single bamboo species and only rarely are more than one species found together. In the wet evergreen forests of *Dipterocarpus* spp., *Calophyllum* sp. and *Artocarpus* sp. in the Andamans, one finds the bamboo *Dinochloa andamanica*. Under oak, deodar, spruce and silver fir in northern India, *Arundinaria* is most frequent, whereas under the dry deciduous type, *Dendrocalamus strictus* is most common.

Species	Character	Average height	Internodes	Diameter	Wall thickness	Culm sheath dimensions	Remarks
		in feet (meters)	..... *inches (centimeters)*				
Bambusa arundinacea	Densely tufted, thorny	80-100 (26-30)	12-18 (30-45)	6-7 (15-18)	Cavity ⅓ of culm	12-15 (30-37.5) long 9-12 (22.5-30) wide	Soft wooded; branches from base
B. polymorpha	Congested clumps	50-90 (16-28)	15-24 (37-60)	3-6 (7.5-15)	Thick	6-7 (15-17.5) long 12-14 (30-35) wide	Sheaths thick
B. tulda	Tufted	20-30 (6-9)	12-24 (30-60)	2-4 (5-10)	0.3-0.5 (.75-1.25)	6-9 (15-22.5) long 6-10 (15-25) wide	Aerial roots first 9-10 feet (3m.)
Dendrocalamus hamiltonii	Clumps, dense thickets	80 (26)	12-20 (30-50)	4-5 (10-12.5)	0.3-0.5 (.75-1.25)	—	Sheaths stiff, persistent
D. longispathus	Tufted	60 (18)	18-30 (45-75)	3-5 (7.5-12.5)	0.3 (.75)	—	Branches only on upper part; long fragile sheaths
D. strictus	Congested clumps	20-50 (6-16)	12-18 (30-45)	1-3 (2.5-7.5)	Thick	—	Sheaths variable
Melocanna bambusoides	Singly at 2-3 ft. (1 m.) intervals	40-70 (13-23)	10-22 (25-55)	1-3 (2.5-7.5)	Thin	5-7 (12.5-17.5) long	Lower ⅔ free of branches. Sheaths persistent
Ochlandra travancorica	Tufted, reed-like, dense thickets	6-20 (2-6)	24-60 (60-150)	1-2 (2.5-5)	Thin	—	—
Oxytenanthera nigrociliata	Densely tufted	30-50 (9-16)	18-30 (45-75)	2-4 (5-10)	—	6-16 (15-40) long	Dense black hair
Teinostachyum dulloa	Open clumps	30-70 (9-23)	16-40 (40-100)	2-4 (5-10)	Thin	—	—

Typical of the evergreen, semievergreen and moist deciduous forests of East Pakistan are such bamboo species as *Melocanna bambusoides*, *Bambusa tulda*, *B. teres*, *B. vulgaris*, *Teinostachyum dulloa*, *Oxytenanthera nigrociliata*, *O. auriculata*, *Dendrocalamus hamiltonii*, *D. longispathus* and *Melocalamus compactiflorus*. Associated non-bamboo species in these forests are *Phyllanthus emblica*, *Litsea polyantha*, *Holarrhaena antidysenterica*, *Pterospermum tetragenum*, *P. acerifolium*, *Grewia* spp., *Saraca indica*, *Vitex* spp., and *Ficus* spp. Associated with the bamboo *Melocalamus compactiflorus* is an important climber, *Spatholobus roxburghi* (Ahmed, 1954). Similar information as to vegetation associated with bamboo species needs to be developed for other tropical areas.

Succession

Bamboos are ready colonizers and when not wanted are difficult to eradicate. In many parts of India *Dendrocalamus strictus* is reported to invade open soil areas, and *Oxytenanthera* sp. and *Melocalamus compactiflorus* are stated to persist in the wet evergreen forest, developing to the climax stage. On the other hand, *Melocanna bambusoides*, which is typical of the moist deciduous forest, is indicated as not progressing to the climatic climax. Following flowering and seeding, the culms of most species wither and die and the stand may regenerate from seedlings which germinate in the succeeding rainy season, or sometimes from new culms sprouting from underground rhizomes.

Following disturbances such as burning or extensive clear-cutting, bamboo regenerates readily by producing new culms from the perennial subsurface rhizomes. *Melocanna bambusoides*, for example, invades clearings where shifting cultivation is practiced, spreads rapidly, thanks to its vigorous rhizome growth, and discourages or suppresses other species of bamboo as well as true tree species. To obtain natural regeneration of timber species it is necessary to cut the bamboos repeatedly. Such cutting or maintenance of complete overhead

canopy, particularly on unfavorable soils, causes the bamboo to deteriorate or to be eliminated altogether. More recently, chemical sprays have been experimented with to control the bamboo under such conditions.

Seed production and establishment

For the most part, bamboos flower gregariously but sporadic flowering in patches is common, and annual flowering is known to occur in *Arundinaria wightiana*, *Bambusa liniata*, *Ochlandra rheedii*, and in the species of the Western Hemisphere. Among the species which flower sporadically are *Dendrocalamus strictus*, *D. hamiltonii*, *D. longispathus*, *D. giganteus*, *Bambusa tulda*, *Oxytenanthera nigrociliata*, *O. albociliata*, *Arundinaria falcata* and *Cephalostachyum pergracile*. The ability to predict the year in which flowering will take place would be very useful; but studies in Japan have failed to show any relation between flowering time and age, size of clump, thickness of stem, soil fertility or moisture, exposure to sun, climatic factors, or locality differences. In some species it is reported that plants of different ages may flower at the same time.

In India, the failure to produce new culms one year is held to be a reliable sign of prospective flowering the subsequent year. This has not been shown to be universally true, although observations on clump-forming species, as well as on the single-stem *Melocanna bambusoides* in India, point in this direction. Physiological disturbances caused by injury, cutting, or prolonged hot, dry weather have been mentioned as possible stimulants to flowering but there seem to be numerous exceptions. Obviously more study is needed on this question.

In the gregariously flowering species the interval from germination of the seed to the next general flowering establishes the life cycle, which seems to be fairly constant. Life cycles have been determined for certain species as follows:

	Years
Arundinaria falcata	28-30
Bambusa arundinacea	32
Chusquea abietifolia	32
Dendrocalamus strictus	32
Bambusa tulda	35-40
Melocanna bambusoides	45
Bambusa polymorpha	60
Phyllostachys nigra	60

According to Troup (1921), gregarious flowering takes place in three stages: preliminary sporadic flowering, gregarious flowering, and final sporadic flowering, with varying intervals between these stages. It may occur over small areas or over hundreds of square miles. It has been observed to begin in one locality and to spread in a definite direction, requiring several years to extend over the entire flowering area. This is very important in connection with teak regeneration. When the flowering occurs, the culms retain their leaves in the early stage, usually dropping them as flowering proceeds. Flowering occurs usually in December and January. Fruits ripen from February to April, or in some localities to as late as June. Seeds germinate quickly, but can be preserved for three months to two years.

Stand development

The bamboos are of two classes: the more important clump-forming bamboos, with peripheral extension from rhizomes (*caespitose*), and bamboos with single culms scattered over a network of rhizomes (*dumetose*). The first class, represented by the genera *Bambusa*, *Dendrocalamus* and *Guadua*, are generally tropical and cannot endure freezing temperatures. The second class, represented by the genera *Arundinaria*, *Phyllostachys* and *Melocanna*, are usually found in temperate regions. Intermediate between the clump-forming and single-culm classes is the high altitude genus *Chusquea*, some species of which form clumps while others produce single stems.

Growth habits of clump-forming bamboos are well illustrated by the various species of *Dendrocalamus* (Deogun, 1936; Sen Gupta, 1954). *Dendrocalamus* species, after germination, produce a grass-like seedling the first year. The plumule, which appears as a conical bud covered by sheathing scaly leaves, develops rapidly into a thin wiry stem bearing single leaves, alternate at the nodes, the leaf bases covering the stem. Fibrous roots form at the base of the young shoot and successive pointed buds appear on the rhizome. These buds form short rhizomes which curve upward to produce an aerial shoot. This process of rhizome and shoot production continues for several years, and as the previous year's shoots die down, new rhizomes grow deeper and new shoots appear each succeeding year. The clump is formed by these short rhizomes, sometimes as congested, sometimes as open clumps, depending on the species. *D. strictus* requires 12 to 13 years under natural forest conditions, or six years in artificially established stands, to form a mature clump.

Growth habits of the non-clump-forming group are shown by various species of *Melocanna*, which produce laterally spreading rhizomes which may run to considerable distances and send out single culms at varying intervals. Seedlings grow vigorously and form strong culms, becoming quite high in one season and reaching merchantable condition in four to five years. Culm development, according to some observers, depends on average thermal conditions, and even hourly growth rate is reported to vary with temperature fluctuations.

Volume and yield

In natural bamboo stands sales are made on the basis of area or number of culms. Volume and yield data are very meager but figures, which are not entirely satisfactory, have been derived from extraction records in annual reports of forest divisions in India, or from compartment enumerations showing numbers of culms per acre. In Chittagong Hills Tracts in East Bengal, figures of 1,200 to 3,600 culms per acre (3,000 to 9,000 per hectare), and in another stand an average of 6,000 culms per acre (15,000 per hectare), have been reported

FIGURE 2. – *Management of bamboos in India. Millions of bamboos are cut annually and used for making paper, baskets, scaffolding, fences, etc. Twenty-five to thirty bamboos are cut from each clump every four years.*
Courtesy, Forest Research Institute, Dehra Dun

on a three-year rotation (Ahmed, 1954). Experimental weight determinations of *Melocanna bambusoides* in this region indicate that 1,000 culms (entire) weighed 4.4 tons (4.5 metric tons) green or 2.5 tons (2.6 metric tons) air dry. This would mean air-dry weights of 3 to 9 tons (3 to 9.5 metric tons) and 15 tons per acre (38 metric tons per hectare) for the three year rotation, on the basis of the above-mentioned counts.

In India, weighing of dry internodes for paper production purposes gave figures of 4.6 tons (4.7 metric tons) of *Bambusa polymorpha* and 4.1 tons (4.2 metric tons) for *Cephalostachyum pergracile* in the same area, or an average of 8.7 tons per average acre (22 metric tons per hectare), presumably for a three-year rotation. In Burma, in a similar type of forest, a total figure of 19.5 tons (20 metric tons) is reported for these two species. *Melocanna bambusoides* is reported to have yielded 8.3 tons of dry culms per acre (21 metric tons per hectare). *Bambusa arundinacea* yields varied greatly, from 1 to 14.5 tons of dry internodes per acre (2.5 to 36 metric tons per hectare), but the average of a large area is said to approach the higher figure. Very striking data are available for yields from plantations in southern Louisiana and Savannah, Georgia, in the United States (Sineath, 1953).

Pests and diseases

Bamboo stands present few serious insect or disease problems. Attacks have been noted of *Estigmena sinensis*, and *Cyrtotrachelus longipes* on the top bud, locusts, termites, and aphids; the bamboo scales, *Asterolecanium miliaris* and *A. bambusae*; *Ochrophora montana* on seeds; as well as the fungus, *Loculistroma bambusae*. Control of the latter consists of removal and burning of affected culms, and in some cases coccinellid beetle have been successfully established as predators on the scales. Much more serious is the powder post beetle, four species of which (*Dinoderus brevis*, *D. minutus*, *D. ocellaris* and *D. pilifrons*) can render bamboo culms useless after felling. A cerambycid, *Stromatum barbatum*, has also been reported. Control of these beetles is achieved by confining cutting to the cold season when beetles are least active, and keeping the cut culms in water to leach out the disaccharides on which the insect feeds. Direct control measures include external application of DDT in diesel oil, kerosene (5 percent), or water suspension; dinitro-o-cyclo-hexylphenol; and impregnation by resin, creosote, Wolman salts, borax, inorganic salt solutions, or Rangoon oil. Heating in a kiln is also reported to be effective.

Fast-growing vines can smother young bamboo seedlings and transplants. Successful control has been secured by spraying these climbers with a 2,4-D solution.

Fire and grazing have been mentioned as injurious agents. Although bamboo is able to recover from burning and some grazing, young seedlings and sprouts in newly regenerated areas need to be protected against both. If cutting operations leave too few culms standing, strong winds may cause serious blowdowns and breakage. Such operations should only be conducted in areas subject to wind storms if one is prepared to risk this possibility.

Rats, porcupines, squirrels, hare, deer and monkeys are known to damage young bamboo by gnawing rhizomes or eating tender shoots or seeds. Goats and cattle, besides eating juvenile foliage, also cause damage by trampling the rhizomes; monkeys can break young culms by jumping, and elephants can damage entire clumps in feeding or by trampling.

Silvicultural Practice

Silvicultural practice with bamboos, largely restricted to the Asian area, is relatively simple and closely adapted to the striking generic and silvical features just described. In general, the mature culms are cut and regeneration obtained from new culms produced annually from underground rhizomes, and this relatively simple practice is followed everywhere regardless of the species or type of forest. Only after gregarious flowering, usually at long intervals and after which the culms of most species wither and die, is regeneration ordinarily obtained from seed.

Both clear-cutting and selection systems are commonly employed in bamboo forests. Practice varies somewhat according to the growth habits of the two great classes of bamboos previously described, i.e., the more important class with peripheral extension from rhizomes, thus clump-forming; and a second class, less important, which produces single culms scattered over a network of rhizomes. With clump-forming bamboos, the clump itself is the working unit to which thinning, improvement or harvest cuttings are applied. In the non-clump-forming group the regeneration area is similar to that of an ordinary forest, except perhaps on a smaller scale, with single scattered culms forming the working stock over any suitable cutting area.

In both classes, under the selection system, the mature culms are cut on a short felling cycle, usually three to five years. The best age to cut the culms for marketing varies with species but ordinarily ranges from two to six years. Generally, the larger species require a longer time to reach harvesting age, though the time required depends in large part on the condition of the rhizomes. Overmature culms start to decay, reducing their quality and market value of the stems, and the usual silvicultural precautions must be taken to preserve maximum vigor and productivity of rhizomes and culms, such as by cutting out overmature, defective and unmerchantable culms and securing even distribution of culms within each unit stand or clump.

Under the selective system most frequently applied to the clump-forming bamboos, the clump itself forms a small sample in which thinnings, improvement cuttings and harvest cuttings are conducted, congestion avoided and even distribution of the culms secured. Under this system, newly propagated bamboo, whether from seed, rhizome or culm-cutting, takes from four to seven years to reach a normal clump of full-sized culms capable of normal annual production of new shoots, though generally, seedlings take a little longer to reach this stage. Cutting cycles of two to five years are preferred — but three- or four-year cycles seem to be the optimum for maximum vigor and productivity of clumps. Selective cutting should be conducted so as to cause a minimum of disturbance, and it is essential to retain a portion of the old culms (that is, culms more than one year old) preferably, all second-year, in addition to the first-year, both for mechanical support of new shoots and to maintain the rhizomes in full vigor. Due consideration must be given to even spacing and the necessity to relieve congestion.

However, elaborate cutting rules may become necessary. Felling rules followed in Southeast Asia prohibit cutting of shoots of the last rains, removal of roots, or cutting culms at more than 1 foot (30 centimeters) from the ground, except where density of the clump makes this impracticable. Similar elaborate rules have been developed in India (Seth, 1954) for *Dendrocalamus strictus* and a few other species, involving time of fellings, height of culm cutting, number of culms to be cut, cleaning and improvement thinning. Supervision to assure compliance with the rules then becomes very important but is extremely difficult.

These disadvantages are overcome under the clear-cutting system with its simplicity and concentration of working, and suitability for mechanization; but such advantages are again offset by the need for a considerably longer cutting cycle (a clear-felled clump taking longer to mature into a full-sized production stage again) and perhaps greater liability of clumps to deterioration and mortality. The choice of a system is, therefore, a matter for decision by individual forest owners, though bamboo forests worked over a long period of years seem to indicate that area for area, selective cutting gives a somewhat greater yield than clear-cutting and is preferable.

In the case of noncaespitose bamboos, although clear-felling again would be most practical and is more frequently used, it seems desirable even under this practice to retain a few stems per acre, regularly spaced, so as to ensure maximum vigor and productivity of rhizomes.

Whatever system is practiced, the possibility of gregarious flowering taking place at a long but more or less regular interval of years over the entire bamboo forest, with all clumps eventually dying, must always be borne in mind. Following gregarious flowering, regeneration is ordinarily obtained from seed germination, which occurs at the start of the following rainy season. Clearing the area is the only suitable procedure.

FIGURE 3. – *A clump of kyathoung* (Bambusa polymorpha), *in the Pyinmana forests of Burma, which had flowered two years previously. After flowering, the culms withered and collapsed. Gregarious flowering of the current year is visible in the background.*

Courtesy, Pyinmana Division, Burma

The ground should be bare and the area should be protected against fire and grazing. Seedlings usually carpet the ground, particularly where the mineral soil has been newly exposed. Generally speaking, with proper protection, the seedlings subsequently succeed in suppressing the regeneration of trees.

Cleaning operations relieve congestion in clumps and dense stands, promote regeneration and facilitate harvesting. Weeding is usually necessary only after seeding, to reduce competition for the seedlings from undesired tree species. Improvement cutting and thinning may be conducted to remove those mature culms which would interfere with natural bamboo regeneration. Pruning is practiced only with those species which produce thorny thickets. Although elaborate tending is seldom required, prescriptions for such work are included in many working plans in Indian forests. Here again, the ability to provide supervision of such work will govern their application.

In some areas, artificial regeneration is resorted to after clear-cutting. Direct seeding has been used successfully, by line sowing, both irrigated and non-irrigated. Propagation methods have been developed successfully in Asia and in tropical America (McClure, 1952).

Research Requirements

The gregarious nature and vigorous growth of most bamboos require that they be considered as an important element in the silvicultural practice of the wet evergreen, the moist deciduous and dry deciduous forest. Where the true tree species of these forests are more important for commercial or protection purposes than the bamboo, measures of controlling the latter need to be developed and applied. But where the requirements for rapidly grown uniform raw materials are paramount, then management of natural bamboo stands, or even propagation and establishment of bamboo plantations, deserve serious consideration. In both cases, there is a need for concentrated research in many phases of bamboo silviculture and management. This is especially important in view of the rapidly increasing demand for bamboo for numerous uses, and particularly for pulp and paper, as well as for housing construction.

Research could well devote attention to the following problems. Flowering, seeding, sprouting, and growth habits are known for many species in many localities, but there is conflicting information in the literature which requires careful observation and study on a species and locality basis. Records of phenology and particularly of gregarious flowering should be collected and maintained. The species *Dendrocalamus strictus* appears to have been carefully studied, but few others are covered adequately. The annual production of new culms per clump as affected by age, treatment, and origin from seed or sprouting from rhizomes should be observed more carefully and systematically.

Experiments are needed on clear cutting and selective cutting, on rotation age, cutting cycles, and cutting intensities for the economically important species, similar to work done on *D. strictus*. This is particularly urgent for non-clump-forming species.

All aspects of artificial regeneration, especially optimum planting season, for various soil and climatic conditions should be investigated. Propagation methods are well recorded, but need local trials to improve and standardize local practices. Field tests of results from introduction gardens would be very useful.

Protection measures are fairly well known, but treatments to prevent damage to cut culms, especially for pulp and paper purposes should be standardized.

Volume and yield data are urgently needed. A simple sampling procedure for determining such facts as age and number of clumps, culms per clump, and average weight, on an acre basis, would be desirable.

Improved forest management methods for bamboo would be greatly facilitated by such research.

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Commodity Report

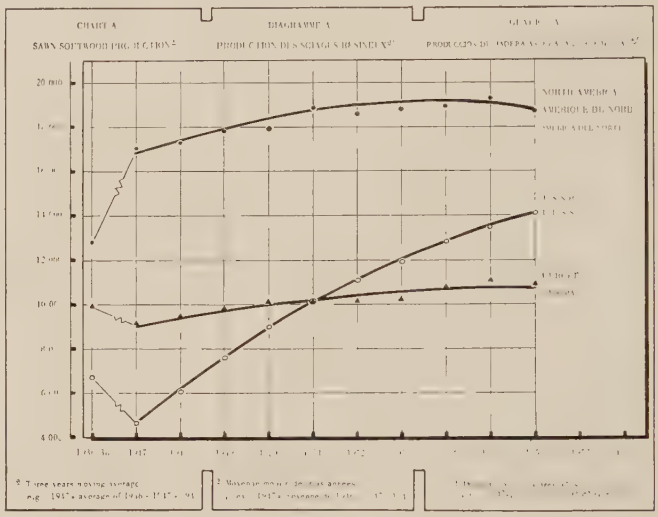
Sawn Softwood

This report deals chiefly with the development of the European sawn softwood market in the postwar period, but also with North America and the U.S.S.R. It will be of interest at this time when changes in the structure of the European economy are under discussion, such as the introduction of the European Economic Community and other efforts at economic integration.

The trends in production of sawn softwood over the years 1946 to 1957 are shown in Chart A which in turn is based on the detailed statistics in Table 1. Output has been rising rapidly in the U.S.S.R. but is generally stabilized in Europe and in North America.

Development of forest industries has reached a high level in both Europe and North America and in Europe especially the sustained yield limits for the forests as presently managed are being approached. In the U.S.S.R., however, many areas of forest are only just being opened up for exploitation and considerable expansion in output can be achieved before either demand is met or the capabilities of the forests are reached.

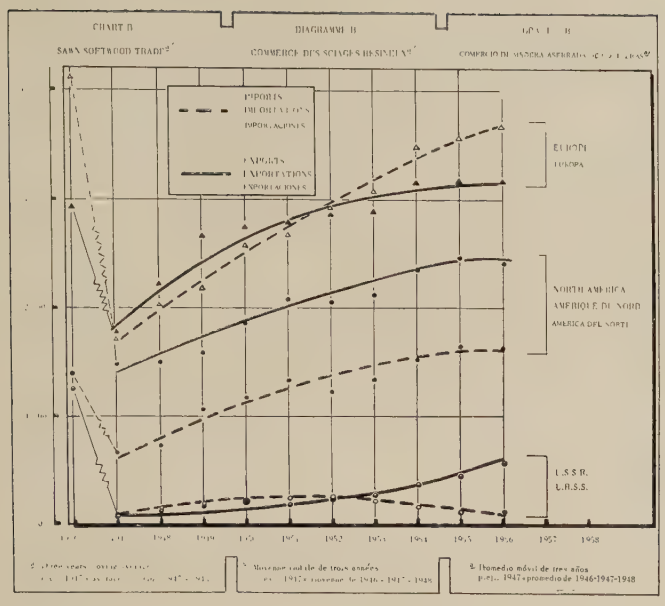
After the setback during the years of the second world war, sawmill capacity in both Europe and the



Tables 1, 2 and 3. – Sawn Softwood: Production, Exports and Imports
(in thousands of standards)

Region	1936/38	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Table 1. – Production													
Europe [a]	9 960	8 835	9 235	9 390	9 850	10 185	10 545	9 670	10 270	10 800	11 275	10 950	10 530
U.S.S.R. [b]	6 760	3 560	4 400	5 950	7 780	9 010	10 190	11 000	12 080	12 550	13 750	13 930	14 370
North America	12 720	15 620	17 270	18 150	16 350	18 910	18 550	18 770	18 560	18 430	19 990	19 040	17 070
Table 2. – Exports [c]													
Europe [a]	2 905	1 015	1 485	2 835	2 355	2 785	3 105	2 470	2 990	3 185	3 295	3 005	3 165
U.S.S.R. [b]	1 227	68	54	98	196	222	200	160	279	373	498	472	736
North America	6 235	1 255	1 775	1 410	1 325	2 050	2 215	2 000	1 985	2 385	2 695	2 310	2 185
Table 3. – Imports [c]													
Europe [a]	4 100	1 315	2 020	1 810	2 270	2 420	3 075	2 555	3 115	3 515	3 825	3 315	3 815
U.S.S.R.	—	47	86	147	205	217	197	266	213	166	131	105	89
North America	1 375	530	585	855	750	1 620	1 185	1 200	1 330	1 500	1 755	1 680	1 455

[a] Includes Turkey, excludes U.S.S.R. [b] Total known, breakdown into sawn softwood by Secretariat. [c] Total intra- and interregional.



U.S.S.R. recovered and prewar output volumes were surpassed. North American production increased during the war and continued to increase, but at a slower rate, for several subsequent years.

The annual statistics (Table 1) show that while U.S.S.R. output increased steadily from 3.5 million standards in 1946 to nearly 14.5 million standards in 1957, the production of North American and European sawmills has been subject to fluctuations. In Europe, a drop in output was experienced in 1952 and again in 1956 and 1957. A peak year in European production was 1955, with over 11.25 million standards. In several countries, policies for protecting reserves of foreign exchange and guarding against inflationary tendencies, have served to restrict construction activities and thereby the demand for sawnwood. In other countries, measures have been taken to restrict forest outturn in order to reduce overcutting or to build up growing stock. Changes in technology and in consumer habits have contributed to the increase in competition between sawnwood and other building materials, both wood products and others, generally to the detriment of sawnwood.

Among major producing countries of Europe, the postwar growth in sawn softwood output was particularly noteworthy for Poland (from about 410,000 standards in 1946 to 1,362,000 standards in 1957) and Austria (269,000 to 840,000 standards) where worn-out industries have been rebuilt. Declining production has been recorded for Germany, both Western and Eastern, as overcutting has been scaled down toward the sustained yield capacities of the forests.

Trade

According to the export statistics (Table 2), nearly a third of the 1957 European production was traded outside the producing countries. The trend in exports for Europe, U.S.S.R. and North America has been generally upward (Chart B) in the postwar years, but prewar levels were not attained in the case of Europe until 1953, and exports of the other two areas remain well below prewar levels. According to available figures, the annual sawn softwood exports of the U.S.S.R. averaged nearly 1.25 million standards during the prewar period 1936/38, dropped to an annual average of less than 75,000 standards in the immediate postwar years and recovered gradually to 736,000 standards in 1957.

North American exports of sawn softwood apparently have had relatively little impact on the European market, and even when domestic demand has decreased there has been little increase in overseas marketing. Canada now ships about three quarters of its total exports of sawn softwood to its southern neighbor, the United States of America. In the three immediate postwar years, these shipments constituted slightly less than half Canada's sawn softwood exports.

The average annual volume of North American shipments of sawn softwood to Europe declined from 566,000 standards during 1946/48 to less than 360,000 standards in 1955/57. European needs for large dimension timber may be considered to provide a "floor" to the volume of imports from North America below which average imports are not likely to fall.

During the period 1948 to 1951, in spite of the great internal needs for building materials, Europe was a net exporter of sawn softwood (Chart B). Since that time, however, imports have increased faster than exports until in 1957 they exceeded the latter by 650,000 standards. A major supplier of sawnwood for Europe has been the Soviet Union with shipments of 343,000 standards in 1954, 438,000 in 1955, 443,000 in 1956 and 689,000 in 1957.

Consumption

Disregarding changes in stocks, the (apparent) consumption of sawn softwood may be calculated from production and trade data (Tables 1, 2, 3) to show the following (Table 4):

Table 4. – Average Annual Apparent Consumption

Region	1936/38		1946/48		1955/57	
	Total, in 1,000 stds	Stds *per* 1,000 *capita* [a]	Total, in 1,000 stds	Stds *per* 1,000 *capita* [a]	Total, in 1,000 stds	Stds *per* 1,000 *capita* [a]
Europe (excl. U.S.S.R.)	11 155	29	9 090	22	11 415	26
U.S.S.R.	5 535	29	4 660	27	13 560	68
North America	7 860	56	16 190	100	17 930	97

[a] Basis, population 1937, 1948, 1956.

These figures show relative stability in *per caput* sawn softwood consumption in Europe and North America since the last war. A different stage of development exists in the U.S.S.R. and *per caput* consumption

is increasing as additional supplies are made available to the economy.

It is expected that these trends will continue for the next several years. North American and European unexploited timber resources are no longer available at costs which would make sawn softwood more competitive with other construction materials. In the U.S.S.R., on the other hand, forest resources are still only partially developed and continued expansion in production and exports can be anticipated.

Development in 1957/58

After the weakening recorded in 1956, the European sawn softwood market in 1957 showed a greater upward trend than had been expected. Total imports reached 3.9 million standards as against 3.4 million standards in 1956. The increased volumes imported by Western Germany, Eastern Germany and the United Kingdom were the most marked, but several other countries also bought more sawn softwood from European sources.

A number of factors were responsible for this development. Mild weather enabled building activity to continue through the usually slack winter months. Importers' stocks were low at the beginning of 1957, as they had been sharply reduced in the course of 1956 in a number of importing countries due to the increased financial burden of stock holding consequent upon tighter credit and dearer money, and because of apprehensions on the future course of sawnwood consumption. The higher demand evoked an adequate response from the exporting countries, by Austria on account of a high volume of storm-fellings, and by Sweden by drawing upon available stocks. Importers were able to build up their stocks, and at the end of 1957 stocks were high in most importing countries.

Events on the European sawn softwood market in the course of 1958 have again demonstrated the sensitivity of this market to general trends in the European economy. In autumn 1957 there was a good deal of uncertainty as to the extent to which the curbs then being applied to the economies of several European countries would affect the development of industrial and constructional activity. The hope of continued stability which prevailed at that time was linked to a moderately optimistic assessment of general economic trends.

In fact, these hopes were not realized: the year 1958 was not on the whole a favorable one for the European timber market, although it should be noted that this does not apply to the whole of Europe, nor could it be described as a serious recession. While the setback was certainly pronounced, considered against the background of the relative stability which the market has now enjoyed for five years, in magnitude it cannot be compared with recessions which the market had known in earlier years.

With industrial activity in many sectors declining in western Europe, and constructional programs running in general somewhat lower than in the preceding year, a certain fall in consumption and demand seemed inevitable. This alone was sufficient to induce a cautious approach to purchasing by the main importing countries. In addition, buyers were influenced by anticipation of price reductions and fears of the ultimate repercussions of the United States recession on the European economy. In the United Kingdom the release of the last batch of government-held stock to the trade diminished the year's import requirements.

Most exporting countries had ample supplies on offer, and some exhibited an eagerness to effect sales, but purchasing was slow and important downward adjustments of prices occurred. It was some time, however, before price concessions stimulated buying, since in many cases importers held off buying in the expectation of even further price falls.

The 1957/58 economic recession in the United States and Canada was accompanied by a sharp falling off in demand for timber. At the same time, high interest rates led to a decline in construction which contributed to a decreased rate of sawnwood production in both countries. As measured by the gross national product, the recession in the United States reached a turning point in the second quarter of 1958. Building and construction, which account for about 70 percent of United States consumption of sawnwood (including hardwood) turned upwards in June, and the consumption of sawnwood for boxing and crating and in manufactures started to improve in May and has since increased steadily.

Production

In 1957, European sawn softwood production (excluding U.S.S.R.) dropped below the 1956 level by about 400,000 standards (see Table 5). The situation was unusual in that the share of the main European exporting countries in this decline was comparatively small, being altogether only about 90,000 standards, while that of the chief importing countries was proportionately higher. This reduction was especially exemplified in the output of Western Germany which fell by some 290,000 standards. Although it should be borne in mind that this country's production for 1956 was comparatively high, partly owing to large stocks of sawlogs at the beginning of that year, and partly because of the wind-blown timber of 1955 being processed in 1956, nevertheless the decline shown for 1957, by comparison with 1956, was significant; in fact, production for Western Germany was, at 1,197,000 standards, the lowest since the end of the war.

The decline in total European production in 1956 had been the consequence of a lower volume of international trade in that year, but this was not the case with the 1957 decrease. On the contrary, total 1957 import figures for sawn softwood exceeded those of 1956 by some 500,000 standards. This increase in international trade in a period of decreased production was possible because, as already said, the decline in out-

Table 5. – Production of Sawn Softwood
(in thousands of standards)

Country	1953	1954	1955	1956	1957	Jan.-June	
						1957	1958
Austria	684	804	826	839	840	417	431
Belgium	75	70	75	75	70	41	41
Bulgaria	107	100	103	85	85*	45*	40*
Czechoslovakia	862	800	877	853	831	415	408
Denmark	62	60*	60*	64*	68*	30*	33*
Finland	904	1 019	1 074	810	825	430	534
France	770	907	1 018	1 038	1 006	364	385
Germany, Eastern	663	643	613	591	563	282	274
Germany, Western	1 275	1 263	1 399	1 487	1 197	620	556
Greece	34	37	37	42	38	11	13*
Hungary	16	15	13	10	15	6	6
Ireland	7	5	5	5	4	2	2
Italy	227	201	179	174	158	85*	77*
Luxembourg	6	7	5	6	6	4	3
Netherlands	16	14	14	13	14	5	5
Norway	345	348	366	410	400	200*	200*
Poland	1 149	1 327	1 346	1 320	1 362	733	713
Portugal	88	105	118	123	124	58	62
Romania	690	684	546	586	576	295	261
Spain	126	158	165	204	209	99	98
Sweden	1 491	1 600	1 753	1 589	1 548	780*	810*
Switzerland	195	198	218	218	199	116	107
United Kingdom	54	62	53	52	52	24	24
Yugoslavia	349	288	270	258	259	111	97
Total, Europe	10 190	10 720	11 130	10 850	10 450	5 170	5 180
U.S.S.R.	12 080*	12 550*	13 750*	13 930*	14 370*	—	—
Canada	3 636	3 639	4 032	3 859	3 187	1 798	1 823
United States	14 929	14 787	15 959	15 182	13 884	7 060	6 395
Total, North America	18 560	18 430	19 990	19 040	17 070	8 860	8 220

* Estimated.

put of the main exporting countries was small and their stocks were plentiful.

Figures available for sawn softwood production for Europe as a whole in the first half of 1958 show no appreciable changes, but marked fluctuations in output have occurred in several countries. Czechoslovakia, Poland, Western and Eastern Germany cut down their production. Finland, France and Austria stepped up output in comparison with the same period of the previous year. Production in Finland climbed from 430,000 standards to 534,000 standards — a direct consequence of the increased felling of sawlogs after the devaluation of the Finnish mark in autumn 1957. In most other countries, the level of sawnwood production was maintained or there were only minor changes. The total figure for Europe for the first half of 1958 is estimated at some 5,180,000 standards, only 10,000 standards less than for the same period of the previous year.

Production of sawn softwood in Canada during the first half of 1958 amounted to 1.82 million standards as against 1.80 million the previous year. The corresponding figures for the United States are 6.4 million and 7.1 million standards. The latter's production during 1958 is expected to total about 13.2 million standards, or 5 percent less than in 1957.

Consumption

The slowing down of building activity in several European countries in the latter part of 1957 partly contributed toward the decrease in total European consumption of 350,000 standards below 1956. This slackening in housing activity became accentuated and widespread in the course of the first half of 1958, and will doubtless be reflected in the total consumption for the year when final figures are available. However, in the second quarter of 1958 there was the same or an even higher rate of construction than during the comparable period of 1957.

Consumption in the United Kingdom declined by 9 percent in the first half of 1958 as against 1957. For Western Germany and the Netherlands, the corresponding declines were 9 percent and 19 percent respectively.

Total consumption of sawn softwood in the United

States during 1958 is forecast at about 14.6 million standards, or about 3 percent below 1957 consumption and about 13 percent below the 1955 peak.

Trade

After the record volume of European trade in sawn softwood in 1955, the drop in 1956, and the recovery in 1957 (see Tables 6 and 7), 1958 is again expected to show a decrease. Although plentiful supplies were available, the atmosphere of the market was uneasy and characterized by a hesitant purchasing policy. This was due to the continuous reductions of f.o.b. prices and freight rates; uncertainty regarding future consumption; dear and scarce money at the beginning of the year in most of the importing countries; and finally speculation as to if, when, and to what extent the recession in the United States would make itself felt in Europe. At the beginning of the buying campaign importers bought only quantities that might be resold immediately. Later on, after the first price reductions, their reluctance to proceed to large-scale purchasing was strengthened by the general feeling that prices would decline even more. Thus, an almost hand-to-mouth purchasing policy continued throughout 1958.

At the beginning of the winter 1957 58 the prospect for 1958 had seemed an apparently balanced supply demand situation, with trade at a somewhat lower level than in 1957. But in December 1957, some exporters went into action despite the difficult import situation, and a keen competition developed. The policy of the U.S.S.R. was apparently to ensure that its volume of sawn softwood exports on the European market equalled those of the previous year. Finland was attempting to take advantage at the beginning of the season of its improved position after the devaluation. Of the exporting countries, Sweden alone remained comparatively unmoved. But this has meant a reduction in Sweden's volume of trade as a whole, and in consequence it is not unlikely that stocks at the end of 1958 will prove to have been high. At the time of writing, it seems that Scandinavian shippers may have preferred to carry over higher stocks into 1959 than they did in 1957 58.

In the United Kingdom, total imports for the first half of 1958 dropped by a good 100,000 standards from the first half of 1957; only imports from Canada exceeded the volume imported during the same period of the previous year — a period during which high freight rates virtually priced Canadian softwood out of the European market. Even the Netherlands and the

TABLE 6. – IMPORTS OF SAWN SOFTWOOD
(in thousands of standards)

Country	1953	1954	1955	1956	1957	Jan.-June	
						1957	1958
Austria	0.3	0.4	0.4	0.4	0.5	0.2	0.3
Belgium-Luxembourg	104.0	129.0	147.0	117.0	142.0	54.0	31.0
Bulgaria	—	—	—	—	1.4	—	
Czechoslovakia	7.9	20.0	20.0	29.0	65.0	17.0	19.0
Denmark	146.0	174.0	133.0	106.0	123.0	47.0	38.0
France	86.0	84.0	103.0	161.0	176.0	80.0	66.0
Germany, Eastern	11.0	19.0	26.0	47.0	123.0	39.0	46.0
Germany, Western	386.0	517.0	609.0	502.0	600.0	248.0	237.0
Greece	31.0	42.0	40.0	55.0	53.0	21.0	20.0*
Hungary	123.0	117.0	112.0	109.0	131.0	47.0	51.0
Iceland	7.6	10.0	9.6	13.0	11.0	3.1	3.0*
Ireland	34.0	51.0	53.0	43.0	26.0	8.1	20.0
Italy	298.0	354.0	351.0	377.0	390.0	197.0	189.0
Netherlands	333.0	383.0	404.0	389.0	422.0	162.0	89.0
Norway	6.6	17.0	24.0	13.0	12.0	6.7	4.5
Poland	12.0	—	—	—	12.0	5.8	0.6
Portugal	1.1	1.8	1.6	2.1	1.6	0.7	0.3
Spain	6.9	11.0	13.0	18.0	12.0	5.3	9.0
Sweden	14.0	15.0	12.0	7.7	10.0	2.0	5.4
Switzerland	12.0	15.0	24.0	33.0	30.0	16.0	11.0
United Kingdom	1 427.0	1 481.0	1 709.0	1 279.0	1 458.0	539.0	427.0
TOTAL, EUROPE	3 050.0	3 445.0	3 790.0	3 305.0	3 800.0	1 500.0	1 270.0
U.S.S.R.	213.0	166.0	131.0	105.0	89.0	35.0	41.0
Canada	45.0	51.0	65.0	89.0	75.0	36.0	37.0
United States	1 287.0	1 450.0	1 688.0	1 589.0	1 379.0	643.0	—
TOTAL, NORTH AMERICA	1 330.0	1 500.0	1 755.0	1 680.0	1 450.0	680.0	—

* Estimated.

Table 7. – Exports of Sawn Softwood
(in thousands of standards)

Country	1953	1954	1955	1956	1957	Jan.-June 1957	Jan.-June 1958
Austria	594.0	704.0	675.0	733.0	697.0	353.0	321.0
Belgium-Luxembourg	0.4	0.8	3.4	7.6	5.3	3.6	2.1
Bulgaria	—	—	—	0.1	0.4	0.2	—
Czechoslovakia	117.0	126.0	119.0	90.0	122.0	46.0	57.0
Denmark	—	—	1.1	5.6	11.0	5.7	4.0
Finland	675.0	729.0	779.0	635.0	704.0	252.0	198.0
France	97.0	101.0	145.0	91.0	67.0	36.0	31.0
Germany, Eastern	3.8	2.2	0.3	0.1	2.4	0.3	1.9
Germany, Western	6.2	16.0	11.0	40.0	40.0	24.0	12.0
Ireland	0.1	0.2	0.1	0.3	0.2	0.1	0.2
Italy	0.1	0.1	0.4	0.3	0.3	0.1	0.3
Netherlands	0.6	1.0	2.6	1.7	1.9	0.7	1.4
Norway	36.0	24.0	24.0	28.0	40.0	17.0	20.0
Poland	56.0	88.0	88.0	79.0	64.0	26.0	18.0
Portugal	35.0	52.0	65.0	71.0	64.0	32.0	33.0
Romania	256.0	295.0	226.0	145.0	192.0	90.0	90.0
Spain	0.4	0.3	—	—	—	—	
Sweden	956.0	937.0	1 067.0	1 012.0	1 096.0	474.0	324.0
Switzerland	2.3	1.8	1.7	1.2	1.5	1.0	0.7
Yugoslavia	152.0	109.0	87.0	67.0	54.0	33.0	20.0
Total, Europe	2 990.0	3 185.0	3 295.0	3 005.0	3 165.0	1 395.0	1 135.0
U.S.S.R.	279.0	373.0	498.0	472.0	736.0	203.0	195.0
Canada	1 745.0	2 102.0	2 381.0	2 034.0	1 877.0	865.0	881.0
United States	239.0	283.0	315.0	278.0	311.0	154.0	—
Total, North America	1 985.0	2 385.0	2 695.0	2 310.0	2 185.0	1 020.0	—

Western Germany had a reduced volume of imports during the first half of 1958.

The northern exporting countries, Finland and Sweden, had by the end of August 1958 sold about 570,000 standards and 575,000 standards respectively, for delivery in the current shipping year, thus reaching about 90 percent (in the case of Finland) and only 70 percent (in the case of Sweden) of the corresponding figures of the previous year. U.S.S.R. sales to the six principal western European importing countries may for the same period be estimated at 420,000 standards, as against 455,000 standards in 1957.

Austria's sales apparently declined very slightly, despite decreased demand by the Netherlands and France; demand in Western Germany and Italy was maintained.

The weakening of the domestic market in Canada and in the United States during the first half of 1958 was in part compensated by increased exports from Canada to western Europe. From the middle of the year the economic improvement in the United States was reflected in a progressive revival in demand for imported Canadian softwood. Shipments of Canadian sawn softwood to Europe decreased considerably and were in general confined to special categories. Total imports of sawn softwood by the United States in 1958 are expected to amount to about 1.41 million standards, as against 1.38 million in the previous year.

Prices

Prices of sawn softwood on the European market remained remarkably stable throughout 1957. In 1958, drastic downward price adjustments occurred. At the same time, there was a reduction in Baltic freight rates (see Table 8) though not of the same magnitude as the drop in prices. After the devaluation of the Finnmark in September 1957, Finland should have been in the position to make some reduction in its prices; in practice, however, it was faced with considerably higher log prices, higher wages and an export levy introduced in connection with the devaluation. Moreover, the grad-

Table 8. – Timber Freight Rates
(1953 = 100)

Year:	January	March	June	September	December	Whole year
1954	100	96	100	113	181	114
1955	...	142	178	186	176	177
1956	183	194	192	204	...	189
1957	181	182	148	113	107	147
1958	99	98	101			

Source: United Kingdom Chamber of Shipping.

nal lowering of this export levy, instead of ensuring wider profit margins to Finnish shippers as was no doubt intended, had to be used proportionately to reduce export prices under the threat of keen competition. The introduction of the minimum price system in Finland in the middle of the year led to softwood prices being more stable, though at a low level.

The price reductions which did occur during 1958 have been greatest for the lower qualities. Thus, the price gap between unsorted and fifth grades has been considerably widened. A drop in prices of £ 8 (U.S. $22.40) per standard for whitewood was made in connection with the U.S.S.R's second schedule, by comparison with the February offer. Following these reductions, Sweden and Finland gradually lowered their quotations during July and August. At the end of August, Finland's best whitewood was priced at around £ 66 (U.S. $184.80) f.o.b. basis 7 inch U.S. battens. Since in a buyers' market specifications have become more and more an important factor in negotiations, it appears that the smaller undertakings with low-grade assortments and less popular categories will be faced with difficulties.

Outlook

Once again prospects for 1959 depend on what kind of assessment is made of general trends in the European economy. There are certain favorable signs. The upturn in United States business bids fair to continue.

Measures have been taken in many European countries to stimulate economic activity — easier credit, bank rate reductions, etc., which may result in improving timber consumption. Stocks in importing countries, while adequate, are no longer excessive — either in quantitative or financial terms. But while there are evident grounds for optimism — and these are reflected in exporters' estimates for 1959 — importers are anxious not to overestimate the extent of any expected increase in demand.

H. W.

PINES FOR TROPICAL AREAS

The sentence: "There are no indigenous pines in the whole continent of Africa, whether tropical or otherwise" in the article "Pines for Tropical Areas" in *Unasylva*, Volume 12, Number 3, page 121 has been questioned by a correspondent, who cites interesting authorities to show that *Pinus halepensis* may be an exception to the above statement.

"If one consults *Prehistory and Pleistocene Geology in Cyrenaican Libya* (C.B.M. McBurney and R.W. Hey, Cambridge University Press, 1955) one will find that "external molds of cones" were found in the Wadi Derna, Cyrenaica, tufas (page 295). These impressions when compared with "cones of all species of pine now living in the Mediterranean region, the Near East and temperate Europe" showed that "*Pinus halepensis* was the only one whose cones showed the same characteristics". In addition, at Ain Mara (Cyrenaica), about 25 kilometers west of Derna, fossil pollen grains of *Pinus* were excavated from Pleistocene deposits (page, 121 *loc. cit.*). Charcoal fragments from Hagfet ed Dabba (page, 303, *loc. cit.*) were examined by Dr. C.R. Metcalf of the Royal Botanic Gardens, Kew, in the United Kingdom, who reported that "most of the samples consisted of one or other of two distinct coniferous woods. One, in which resin canals could be seen, is probably a pine, and might quite well be *Pinus halepensis* Mill..." Radio-carbon tests place this charcoal and the associated artifacts as being Middle Paleolithic or the earliest Upper Paleolithic, or say, "the fourteenth millennium B.C." (page 234, *loc. cit.*) I think that we can agree that Pleistocene is sufficiently long ago (somewhere between 75,000 and a million years ago) to qualify *P. halepensis* (or at any rate a *Pinus* of some sort even if the evidence of the cone molds is not accepted) for inclusion as an African plant. Even the "fourteenth millenium B.C." in my opinion qualifies *Pinus* (almost certainly *P. halepensis*) as an African species!"

The Work of FAO

Staff Changes

Egon Glesinger, who needs no introduction to readers of *Unasylva*, has been appointed to succeed Marcel Leloup as Director of FAO's Forestry and Forest Products Division. For the past 10 years Dr. Glesinger has been Deputy Director of the Division. He joined FAO in 1946 as Chief of the Forest Products Branch, having previously in 1944 served on the United Nations Interim Commission on Food and Agriculture which defined how forestry and forest products should be included within the scope of FAO as provided for in the original Constitution of the Organization.

André Métro, formerly *Conservateur des eaux et forêts* at the *Ecole nationale des eaux et forêts* at Nancy, France, has been appointed to succeed Irvine Haig as Chief, Forest Technology Branch. Dr. Haig, who joined the Organization in 1951, has rejoined the United States Forest Service, where his duties will require his continued contact with FAO's forestry activities. In particular, he will serve as executive secretary to the Organizing Committee of the Fifth World Forestry Congress to be held in the United States in 1960.

Karl Oedekoven has succeeded Graf S. von der Recke, retired, as Regional Forestry Officer for the Near East. Graf von der Recke served with FAO for five years, most of that time having been spent as Regional Forestry Officer for Latin America. He is now with the *Bundesministerium für Ernährung, Landwirtschaft und Forsten*, Western Germany.

Chandra S. Purkayastha has retired from his post as Regional Forestry Officer for the Asia and Pacific region. In the course of eight years spent at the Regional FAO Office in Bangkok, Mr. Purkayastha developed FAO's forestry program for this wide region. He is succeeded by U Aung Din, who joined FAO from the Burma Forest Service in 1956.

Latin-American Forestry Commission

Ricardo Lavagnino Girón of Guatemala was elected Chairman of the Sixth Session of FAO's Latin-American Forestry Commission which was held at Antigua, Guatemala, from 4 to 15 November 1958. José Paulo Silvairo-Cabral (Brazil) and Gilberto León (Cuba) were elected as Vice-Chairmen and Rafael Viloria Díaz (Venezuela) as Rapporteur.

Formally opened by the President of the Republic of Guatemala, the session was attended by delegates from Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, France, Guatemala, Haiti, Honduras, Nicaragua, the Netherlands, the United States, the United Kingdom, and Venezuela. Observers represented Spain, the Holy See, Unesco, the United Nations' Economic Commission for Latin America, the Organization of American States, and the U.S.A. International Co-operation Administration. Egon Glesinger, then Deputy Director of the Forestry Division, represented FAO and FAO's Regional Forestry Officer, Jean Moser, acted as Secretary to the Commission.

The main feature of the session was the detailed discussion of progress in forestry development in countries of the region, based on the reports submitted by members. It became clear from these discussions that FAO's policy for the future must be increasingly orientated towards collaboration with associations of forest owners, industry and trade, and professional bodies. Throughout Latin America these associations are influential and effective in furthering forestry. The strengthening of state forest services must remain the long-term aim, and in this connection considerable attention was given to the means for developing professional and technical forestry education at all levels to meet the growing needs of public administrations and private enterprise. But remuneration for trained staff must be made attractive, and there must be prospects of continuity of employment.

It is now admitted that the only way to develop still virgin or little exploited natural forests is by settling people in the areas where these are located. Wherever land settlement plans are concerned, forestry authorities must participate very fully in their framing, just as they should follow very closely land settlement policy and the terms on which public domain is ceded, as well as the drafting of laws for implementing colonization projects which frequently place valuable forests in jeopardy and may foredoom land to erosion. The dangers of subsistence farming through shifting cultivation were well revealed during the discussions of the Commission.

Land settlement is generally a slow process but it is going ahead fast in certain countries (Brazil, Costa Rica, Guatemala, Venezuela, etc.). Even so, the proper management of natural forests tends to take second place to the creation of new artificial plantations. The Commission called on governments to rationalize their planting programs, whether to be executed by the State or by private owners with or without state aid. Some delegates vigorously denounced the waste represented by present policies of free, haphazard distribution of planting stock to small landowners.

The work program of the regional research committee was established and action was proposed on the future functioning and financing of the Latin-American Forest Research and Training Institute at Mérida, Venezuela. Seven countries of the region are now contributing financially to this institute whose results during its initial period of establishment were judged very satisfactory.

The Commission asked FAO to organize in 1960 as a regional project a study tour on conifers of Mexico and Central America. Organization of a supply of

authentic seed and better knowledge of the ecological habitat of these generally quick-growing conifers was regarded as essential in connection with planting programs now under way in many Latin-American countries.

FAO was also requested to continue the regional pulp and paper advisory group, whose task is to advise governments on the prospects for developing competitive industries in the light of raw material resources and prospective markets. The undertaking jointly by FAO and the Economic Commission for Latin America of a regional "timber trends study" was endorsed. Long-term market possibilities for tropical hardwoods would be explored through this study. FAO would also arrange for current market developments to be regularly reviewed.

The session closed with a short visit to forest areas around Antigua. Some delegates were able to proceed afterwards to the Fifth FAO Regional Conference for Latin America held at San José, Costa Rica. This Conference endorsed at the ministerial level many of the recommendations decided by the regional forestry commission.

Near East Forestry Commission

The Second Session of the Near East Forestry Commission was held in Cairo from 27 October 1 November 1958. Delegations attended from Iraq, Libya, Sudan, the United Arab Republic (U.A.R.), Ethiopia, France, Italy, and the United Kingdom (Cyprus and Somaliland). Observers were present from Pakistan, Turkey and the United States. The FAO Regional Representative, Dr. A. R. Sidky, represented the Director-General.

Mohammed Kamil Shawki (Sudan) was elected Chairman and Ali M. Alem (Libya) and Ahmed H. Nasharty (U.A.R.) Vice-Chairmen. Donald F. Davidson (Cyprus) was appointed Rapporteur. Karl Oedekoven, the FAO Regional Forestry Officer, served as Secretary assisted by Oscar Fugalli, and the then Director of FAO's Forestry Division, Marcel Leloup, was present throughout the session.

The detailed discussion of progress in forestry development in the several countries of the region was of high interest and is recorded in the final report of the session. Some points made are as follows.

The formulation of balanced land-use policies is coming to the fore in several countries of the region. In Cyprus, a Land-use Co-ordination Committee is in operation and in the Sudan a similar committee has been established on an experimental basis in one of the nine provinces. A central Land-Use and Water Development Board has also been created in the Sudan, and the establishment of shelterbelts is recognized as a cardinal point of forest policy. Attempts are being made to conserve and rehabilitate forest remnants. Efforts are also being concentrated on tree planting, particularly of poplars, in conjunction with large-scale agricultural development projects, as in the case of Afghanistan (Helmand Valley Authority). The agrarian reform now being undertaken in Iraq may have a considerable effect on forestry development in that country.

In Afghanistan, the forest administration still consists of a skeleton staff which is, however, being slowly augmented. Ethiopia has recruited a number of expatriate foresters to set up a forest service. Sudan has created three new posts and employs several expatriates in addition to Sudanese officers. Iran has a central service with 14 divisions plus 11 regional forest departments and 7 smaller forest offices; forest protection has made considerable progress as a result of the creation of a body of armed forest guards. Jordan has a central service and 13 districts under the direction of a senior forestry officer. British Somaliland, whose central forest administration is a division of the Department of Natural Resources, is divided into three districts, each with an assistant conservator of forests and a forester; there is considerable decentralization of authority. Cyprus has had an organized forest service for a long time.

Iraq's forest administration has been remodeled. It will have two directors under the Director-General of Forests, one in charge of forest management and the other for specialized services such as research, planning, surveys, and utilization. The Forest Research Division and the Forest Survey and Management Plans Division are already in operation. In 1957, a new Forest Police Division was established with the responsibility of enforcing the forest law. In Libya, a Department of Forests was established in 1957 under the jurisdiction of the Nazir of Agriculture for Tripolitania, consisting of a director and his assistant, three district forest officers, two agricultural extension officers and a number of forest guards. In the Northern Region of the U.A.R., the forest service is expanding rapidly.

Efforts are being made in many countries either to establish schools for forest guards (Ethiopia, Iran, Iraq, Libya) and for subprofessional personnel (Ethiopia, Cyprus, Iraq, Iran and the Sudan) or to send foresters abroad for training. Jordan now has three students in the United States of America while during the past few years 10 officers have attended courses in Cyprus, the Netherlands and the United States. British Somaliland is sending its rangers to Cyprus, Sudan and Tanganyika, and a Fellowship has enabled a Somali forester to spend four years in the United Kingdom. The Sudan now has 10 students in Scotland (Edinburgh), one in Australia and one in Pakistan. The Northern Region of the U.A.R. has also sent 6 Fellows to Europe and the United States to study forestry. The Near East Forest Rangers' School, which is being established in the latter country, will begin to function in 1959, offering subprofessional training in forestry.

In discussing the whole problem of the incidence of rights of usage on forests in the region, the general view of the Commission was that it was the way these rights of usage are practiced by those who exercise them and not the nature of the various rights themselves

which is at fault. Measures for attempting to solve the problems involved were agreed.

Future action was decided in regard to regional FAO projects and guidance was also given on future work programs of the Forestry and Forest Products Division as affecting the region.

Technical Meetings

Lack of space has hitherto precluded noticing some recent technical meetings in *Unasylva*. For instance, the Fourth Session of the Working Party on Torrent Control and Avalanches (European Forestry Commission) took place in Austria, from 9 to 20 September. Business meetings were held in Vienna when a number of analytical reports commissioned by the last session and prepared by consultants, were discussed and agreed; these related to the building and maintenance of torrent control structures, land use in mountain areas, and the silting of reservoirs.

Subjects studied during the subsequent tour in the Austrian alps were the siting of structures for torrent and avalanche control, afforestation of high altitude zones, and the interrelationship of grazing and forestry on mountain lands.

The scope and trend of the future program of the working party was decided: it will be co-ordinated to parallel fields of action of FAO's European Commission on Agriculture.

The International Chestnut Commission also held a Fourth Session in Yugoslavia from 22 to 30 September, with a study tour from Ljubljana to Belgrade and a post-session tour to Salonike, Greece, from 2 to 3 October.

Representatives from Spain, France, Italy, Greece, Portugal, Switzerland and Yugoslavia participated. Twelve other member countries of the Commission provided reports.

Main discussion centered on how to enhance the usefulness of chestnut cultivation, for watershed protection and for timber and fruit, in the betterment of rural economics. Clearly chestnut had still an important role to play, otherwise the species would long since have lost all economic importance in southern Europe.

Timber Committee of ECE

Delegations from 24 countries, together with three non-governmental organizations, participated in the 16th Session of the Timber Committee of the Economic Commission for Europe (ECE) at Geneva in October last.

The committee re-elected François M. du Vignaux (France) as Chairman and Johan-Otto Söderhjelm (Finland) and Jerzi Knothe (Poland) as Vice-Chairmen.

The hope, expressed by the committee at its 15th Session, of continued stability in the European sawn softwood market had not been realized for 1958. The declining level of industrial activity in western Europe, and the high level of stocks in importing countries at the end of 1957 induced a cautious approach to purchasing. With ample supplies on offer, important downward adjustments of prices occurred. The 1958 level of imports by European countries was probably slightly less than had earlier been anticipated. The timber available from European exporters proved considerably greater than had been estimated a year previously. This would influence forest output plans for 1959.

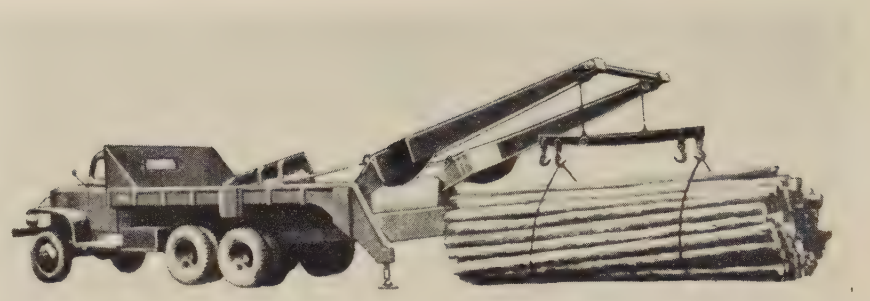
The committee thought there would be improved consumption, increased import requirements and a higher level of trade in 1959. Adequate supplies would be available to meet any likely increase in demand.

The committee decided to review the hardwoods market situation regularly, and requested that a consultation of experts from interested governments be convened by FAO and ECE during 1959 to lay down and define the statistical and other information to be assembled for this purpose.

In allocating priorities for the program of work for 1959, the committee took into account the need to streamline the program and achieve concentration. In regard to utilization studies it decided to give priority to the:

1. industrial utilization of small-sized roundwood and fuelwood;
2. utilization of timber industry waste;
3. search for new outlets for certain non coniferous timber species.

Equipment Section



Mechanical Winch M.F. 10. — Can be self-transported to logging site. On very steep slopes can be self-hauled using its own winch. Chassis having form of a luge, can reach regions inaccessible to animals and tractors.

Specifications: Winch: width 1m., length 1.8 m., height 1.3 m. Engine: Power 6/8 hp. — air-cooling. Drawbar pull: Empty drum 1,500 kg., full drum 1,000 kg. Linear winding speed: 6 speeds from 720 to 4,800 m./h. empty drum. Transport speed of the mechanical winch: 6 speeds from 3 to 10 km./h. Cable capacity: Pulling drum 500 m. of cable of a dia. 9.5 mm.; 2nd pulling drum 1,000 m. of cable of a dia. 6.5 mm. Weight of mechanical winch: with a drum and without cable 460 kg.

Etablissements F.O.C., Avenue Beauséjour, Vienne (Isère), France.

Hydraulic Lift. — Lift can be mounted on chassis of any tonnage and any type. Control secured from cab. Supports, hand or hydraulically controlled, allow for good lifting of load. Vehicle can be used for transportation without removing hydraulic lift device.

Bennes Marrel, Rue Pierre-Copel, Saint-Etienne, France.

Combined Personnel—Cargo Carrier. — Can transport load of 1,500 lb. (680 kg.), equal to its own weight. Converts quickly from personnel carrier to truck by folding seats into platform bed. *Specifications*: Wheelbase 80 in. (2 m.); overall length 131 ½ in. (3.34 m.); overall width 62 in. (1.57 m). Turning radius 10 ft. (3 m.); horsepower 100. Top speed 65 m.p.h. (104 km./h.).

Willys Motors, Inc., Toledo, Ohio, U.S.A.

Nordwerk Grader MVH 55. — New construction for road making and maintenance work. *Specifications*: Total weight without windrow eliminator: 10,375 kg. Motor: 6-cylinder fuel injection diesel motor, VOLVO D-67, cylinder capacity 6.73 liters, power 85 hp. at 1,600 r.p.m. Wheelbars, 5,600 mm.; track, 1,850 mm.; tires, 13.00 × 24, 12 layer; ground clearance min. 360 mm.; length of blade 3,080 mm.; blade height, incl. cutter 605 mm. Tandem-driven rear wheels. Back axle fitted with locking differential. Front wheels can be inclined by hydraulic transmission and locking device for central position. Hydraulically operated blade setting and, when fitted, scarifier setting.

A.B. Nord-Verk, Uddevalla, Sweden.

Sulky. — Single speed self propelled, forward direction only; max. speed 2 m.p.h. (3.2 km./h.) mounted on traction type pneumatic disc wheels. Tire size 6.00 × 16, outside diameter 28½ in. (72 cm.). Air-cooled J.A.P. 3½ hp. 4-stroke engine. Carries ½ ton; handles poles up to 18 in. (46 cm.) diameter and 25 ft. (7.6 m.) length, longer poles dragged. Lifting by hand-operated winch. Pole cradled on machine to make one balanced unit about the wheel centers. Front end rests in an extended "boom" frame which has steering handle and throttle lever controlling engine and hence clutch. Safety type control, engine speed drops when hand is off lever.

Packman Machinery Ltd., Twyford, Berkshire, U.K.

HM Diesel Crawler Tractor 12 hp. — Tractor equipped with planting rill-drawing implement, system G. Helms, particularly recommended by manufacturer for planting in tree-nurseries. Tractor can also be used for logging in conditions where normal tractor not suitable and where only horses could perform the work. Implements are fixed by 3 point linkage of hydraulic power lift device.

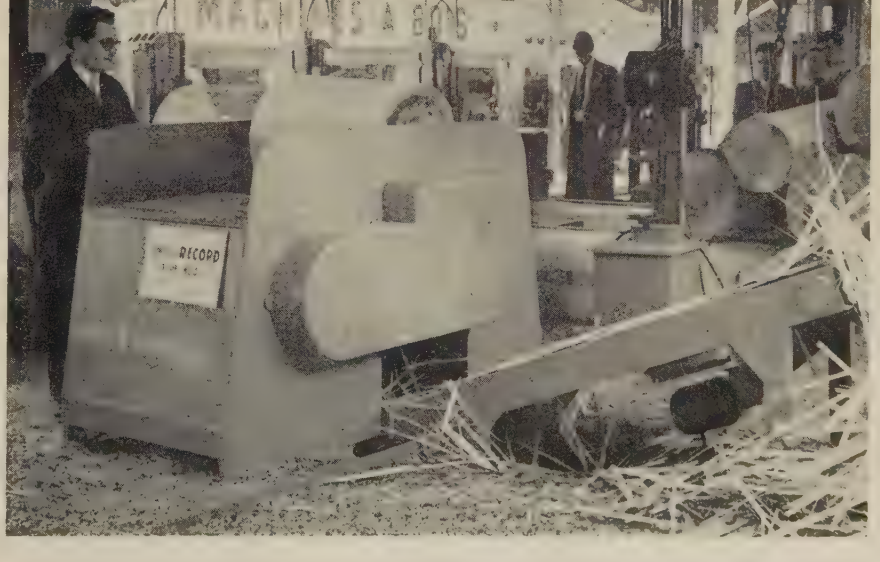
Eimeha Herbert Bohschke KG, P.O. Box 12087, Düsseldorf, Germany.

CL 4-Wheel Tractor. — *Specifications*: Motor Berliet type MDV; no. of cylinders, 4; cylinder capacity 5 lit.; power, 60 hp. at 1.650 rpm.; speeds: 5 fwd. 1 rev., min. 3.7 km./h., max. 28.9 km./h.; footbrake, Westinghouse on 4 wheels; hand brake, on differential. General dimensions: over-all length 3.74 m.; over-all width 2.13 m.; standard wheelbase 2.29 m.; cracks, front and rear 1.72 m.; weight 3,450 kg. On request: 4 steering wheels, closed cab. Side power take-off. Drive pulley. Capstan front and rear. Trailer hook.

Labourier et Cie., Mouchard (Jura) France.

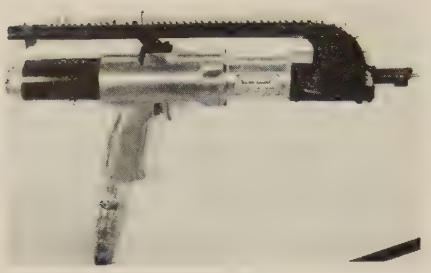
Record-800 Automatic Debarker for Veneer Logs. — For 80 cm. long veneer logs. Rotary motion secured by 2 parallel gear wheels running at approx. 36 rpm. Machine equipped with 10 hp. motor running at 1,500 rpm. and a trapezoïdal belt transmission. Chips and bark waste removed on travelling rubber belt conveyor, 4 m. long, driven by 1 hp. motor.

Société des Etablissements Rennepont, 69, Quai de Valmy, Paris 10e, France.



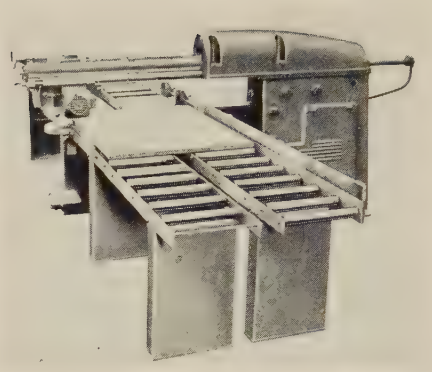
Hydra-Set. — Crane and hoist control load. Installed as link between crane hook and load; entirely self-contained, requires no air or outside hydraulic lines to operate. Unit will raise or lower loads up to 20 tons. Five models from 1 to 20 tons capacity.

Metco Sales and Service Corporation, Arcadia, California, U.S.A.



Semspak Model 600.— Portable self-feeding automatic power screw driver developed for mass assembly operations. Screws contained in a cartridge and automatically fed into driving jaws. Screw supply always visible and preloaded cartridge can replace an empty in seconds. Semspak accommodates screws with $^{7}/_{16}$ in. (11 mm.) min. and 1½ in. (38 mm.) max. length and either Round, Pan, Oval, Flat, Fillister, Hexagon, slotter or Phillips head.

Illinois Tool-Shakeproof Ltd., 10, Old Jewry, London E.C.3, England.



Cut-off Saw Type C.J.4. — Saw used for cross-cutting panels up to 52 in. (1.3 m.) wide. Cutting stroke across board operated hydraulically, controlled by foot pedal. Provided with roller tables. Adjustable stops for repetition cutting to size. Length of stroke adjustable by simple lever movement. Forward speed of stroke adjustable by hand lever between 5 and 150 ft. (1.5 m. and 46 m.) min. Return stroke constant at 200 ft. (61 m.) min. irrespective of forward speed. Machine carries on 18 in. (46 cm.) saw giving max. depth of cut of 5 in. (13 cm.) mounted directly on to 5 hp. motor spindle.

Wadkin Ltd., Green Lane Works, Leicester, England.

British Straddle Carrier MK.2. — Only straddle carrier produced in Great Britain. *Specifications*: Power unit: Perkins L4; 4-stroke diesel engine giving 62 bhp. at 2,000 rpm. 3 speeds fwd. and rev., 1 low and 1 high for each speed, min. 4 mph. (6.4 km./h.) max. 30 mph. (48 km./h.); lifting capacity max. load 20,000 lb. (9,072 kg.). Load can be raised 18 in. (46 cm.); lifting hooks actuated by two hydraulic cylinders. Hooks clamp and lift hydraulically aligning themselves automatically with load. Three models, differing only in width: No. 4266 overall 84 in. (2.1 m.), inside 42 in. (1.1 m.); No. 4866 overall 90 in. (2.3 m.), inside 48 in. (1.2 m.); No. 3466 overall 96 in. (2.4 m.) inside 54 in. (1.4 m.).

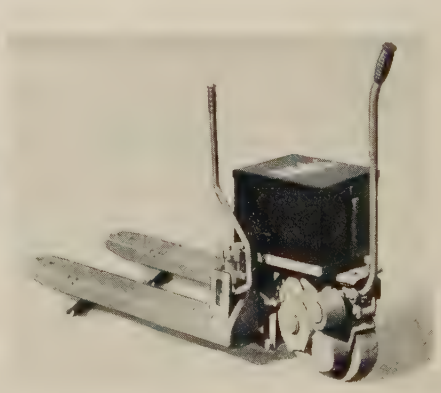
British Straddle Carrier Co. Ltd., East India House, London W.1, England.

Electric Battery Rallet 10 cwts Truck. — Model E 412 P manual or power-operated hydraulic pump and ram. Motor with automatic brake on armature, reduction gearing, controller. Unit offered in variety of small chassis and body designs suitable for 10 cwts. loading. For use in confined spaces, upper floors, gangways, lifts, etc. Pallet forks available in alternative lengths and widths. Battery: Exide traction 12 volt. 87 amp/h.

Wessex Industries (Poole) Ltd., West Street, Poole, Dorset. England.

Lumber King Body. — Mounted on any chassis. *Specifications*: Length 21 ft. 6 in. (6.6 m.); width 95 ½ in. 2.4 m.). Full width roller in front and a split roller in rear, making possible the roll-off delivery of different loads on same trip. Loading space dimensions are such that practically any combination of lengths can be handled.

DeKalb Commercial Body Corporation, [illegible], Illinois. U.S.A.



News of the World

Afghanistan

• A report to FAO's Near East Forestry Commission recalls that the first forestry organization in Afghanistan was the Forestry Branch of the Department of Agronomy, Ministry of Agriculture, established in July 1957. Now the Ministry of Agriculture is being reorganized and a Division of Forestry and Range Management will shortly be created within the Department of Plant Production.

An appraisal of forestry technical assistance needs, both bilateral and multilateral, will be made soon after the current reorganization is completed. Recommendations contained in the 1957 *Report on Forestry Development*, prepared by B. Clarke under FAO's Technical Assistance Program, are now under review. It is hoped that action on the major proposals may soon be initiated.

Two courses in general forestry are now offered in Kabul, one at the Vocational Agricultural School and the other to the junior class at the Faculty of Agriculture, University of Kabul. No other formal forestry training is given at present. It is hoped that in the near future practical forestry training can be given to field staff and that an information and education program can be started to make the general public more forestry-conscious.

Forest area data are incomplete, but a determination of the area supporting trees as shown on aerial photographs should be possible within a year or two. In the meantime, it is estimated that the forest area is about 1,500,000 hectares of a total land area of 73,100,000 hectares.

The only exact afforestation data available are for activities of the Helmand Valley Authority in southern Afghanistan. Under very difficult conditions, an excellent nursery and planting program has been developed in this area during the past five years. There are now seven nurseries with a gross area of 78 hectares scattered along 100 kilometers of the developed portion of the Helmand Valley. Shelterbelts, windbreaks, woodlots for fuel, and amenity plantings account for the bulk of the afforestation program here. During the 1957-58 (winter-spring) planting season, about 415,000 trees were outplanted from the nurseries and 575,000 cuttings were established. Species planted included mulberry, ash, cypress, poplar, walnut, redbud, pine, eleagnus, catalpa, sycamore, willow, tamarisk, and acacia. The nurseries now contain over 2 million trees and the total number of trees planted in the three-year period, 1956-58, is estimated at 3,250,000.

Elsewhere in the country, afforestation is dominated by the establishment of poplar plantations. Except in the vicinity of the coal fields, where pitprops are produced, poplars are grown chiefly for poles, posts, fuelwood, and other local uses. The bulk of the plantings are adjacent to irrigation and drainage ditches, or along natural water courses. Amenity plantings are in progress on treeless hills adjacent to Kabul and other large centers. Planting stock for these urban programs is produced at a number of small nurseries operated by the Ministry of Agriculture.

Canada

• Since the second world war, the top executives of the Hunting Survey Group from Britain, Canada, South Africa, Australia, New Zealand and the United States have met every four years to exchange ideas and experience. At the fourth of these conferences held in Toronto in June 1958, two outstanding contributions to aerial survey practice were studied. The first was the Photographic Survey Corporation's " AUSCOR, " which, by means of associated electronic and electro-mechanical systems, automatically draws maps through a plotting machine far more quickly than could the human operator of the orthodox visual and manual instrument. This new system may revolutionize photogrammetric mapping procedures.

A new associate company in the United States, Photronix Inc., of Columbus, Ohio, was responsible for the other major development; by integrating aerial photogrammetry and electronic computation its machines can provide basic data on highway design for the civil engineer more rapidly and economically than was formerly possible. This is a valuable new tool, for not only does it enable the engineer to increase his productivity, but it also makes it possible for him to improve the economy of his design in new road development.

A report was also given on the new ground survey instrument, the tellurometer, which had been used in the Ethiopian road contract. This instrument, now generally accepted throughout the world, is especially interesting as having been developed in South Africa. There were naturally many other new devices which had been introduced concerning camera design, photography and processing, lenses with little, if any, distortion now in use which transmit more light and therefore allow the use of slower film emulsion; a new fast lens shutter which cuts down image movement on the negatives when they are exposed from low altitudes for purposes of large scale plotting; and the latest electronic photo-printer which extracts all details in highlight as well as deep shadow, and enables the interpreter to extract the maximum information from the photograph.

Cyprus

• Investigations leading up to the evolution of an improved forest inventory procedure were completed in 1956. The new procedure is based on the combined use of aerial photography and ground enumerations. It has been standardized and applied in practice during the last two years as follows:

1. The forests are stratified as near as possible into homogeneous types from aerial photographs, and each forest type or stratum is sampled separately.
2. The sampling method used is a stratified random system employing relatively large sampling units (3 hectares in area) which are laid out and demarcated on the ground for permanent and complete measurement at successive intervals.
3. The sampling intensity varies from 5 percent to 20 percent on an area basis, depending on the area and economic importance of each stratum.

Some 18,000 hectares of *Pinus brutia* forests have already been enumerated by this method of continuous inventory applied on a sam-

pling basis, and it is proposed to apply this method to all the island's coniferous forests in due course.

Ecuador

• Efforts are being made by the FAO Representative in Ecuador, supported by United States Operations Mission and the International Union for the Conservation of Nature, to have the Sorocucho lake area declared as a national park and preserved.

A group of seven small lakes, all of great natural beauty, lie in the mountains at an altitude of 3,200 meters about 30 kilometers from the city of Cuenca. The lakes are bounded by steep, densely wooded hillsides, but the forests are being rapidly destroyed by cutting and burning to permit agriculture.

The problem is mainly a social one. For many years Cuenca produced as a cottage industry fine quality " panama " hats which found a ready market abroad. Today these hats are no longer in demand and the people have to depend on an impoverished soil for the means of existence. This in turn has led to land hunger and extension of cultivation into the forested hillsides.

Finland

• The results of the Third National Forest Survey (leader: Dr. Y. Ilvessalo) are now available as, too, are the results of the Third Survey of Wood Utilization (leader: Dr. V. Pöntynen). These two surveys, which were carried out by the Forest Research Institute give an excellent basis for the future planning of Finnish forestry.

The final results of the important rural labor force studies (leader: Dr. L. Heikinheimo) have also become available. They include studies on the research methods concerning the rural forest labor, on the size and structure of the forest and floating labor force, on the housing conditions of forest workers, and on the proportion of forest work in the labor input of the rural population.

An official report to FAO shows that, according to the 1951-53 National Forest Survey, the forest area, total growing stock and increment have developed as follows since the Second Survey, carried out in 1936-1938:

TABLE 1. – FOREST AREA, GROWING STOCK AND INCREMENT

Item	1938	1953
	... in million ha. ...	
Forest area	21.0	21.9
Growing stock [1]	1 370.0	1 493.0
Increment [2]	41.5	46.0

[1] Including bark.
[2] Excluding bark.

The ratio of different species of wood to the total volume of the growing stock developed in the following way during this period.

TABLE 2. – VOLUMES OF DIFFERENT SPECIES IN GROWING STOCK

Species	1938	1953
	... in million m^3 [1] ...	
Pine	624	663
Spruce	441	533
Birch	257	273
Others	48	4
TOTAL	1 370	1 493

[1] Including bark.

The average growing stock on productive forest land is 80.7 cubic meters per hectare including bark and the average increment 2.5 cubic meters per hectare excluding bark.

Land-ownership has greatly changed compared with prewar times, as appears from the following Table:

TABLE 3. – FOREST LAND OWNERSHIP

Owner	1938	1953
	..... percent	
Private owners	54.6	60.0
The State	35.7	30.6
Companies	7.1	7.0
Others	2.5	2.4
TOTAL	100	100

BRAZIL: *A note on the Curua logging demonstration center on the Amazon appeared in the last issue of* Unasylva *(Vol. 12 No. 4). These photographs show (above) a Russian manufactured S 80 tractor and a D-374-T scraper in use at the center, and (below) the ingenious way in which a Russian D-20-B grader was lifted bodily from the hold of the barge in which it arrived at the center, still strapped to the base of its crate, by a Hyster touring winch mounted on a caterpillar D 6 tractor and Hyster logging arch.*

Courtesy, I. H. Gray

TABLE 4. – WOOD UTILIZATION

Type of utilization	1951	1952	1953	1954	1955	1956	1957	Average 1951-57
	..... *in million m³* [1]							
Export of roundwood	5.50	5.06	2.49	3.72	5.08	4.32	4.00	4.31
Raw material for forest industries	19.78	15.24	15.85	19.54	22.27	19.88	20.06	18.94
Home consumption of agricultural population	Average		7.79	Average		5.83	10.29	11.33
Home consumption of other population	Average		4.31	Average		4.46		
Other purposes	5.80	5.22	4.62	4.80	5.67	5.60	5.48	5.31
TOTAL, WOOD UTILIZATION	43.18	37.62	35.06	40.16	43.31	40.09	39.83	39.89

[1] Excluding bark.

The change in favor of private owners is due to interior colonization, of which the main beneficiaries are the population displaced from Karelia, which was ceded to the U.S.S.R. in 1944.

According to the Third Survey of Wood Utilization, wood was used as shown in Table 4 in 1951-57:

Iraq

• Forestry in Iraq, a report to FAO states, must provide for:

1. *Watershed protection.* Forest and alpine pastures occupy nearly 70 percent of the mountain area forming the watersheds in Iraq of the Tigris and its important tributaries, the Big Zab and Lesser Zab rivers, the Sirwan (Diyala) and the Adhaim rivers. In these areas, therefore, the forests and forest pastures exercise an important influence in controlling floods and in the prevention of accelerated erosion with the consequent siltation of the rivers and all the vital irrigation systems depending on them.

2. *Windbreak plantations.* The cultivated plain areas of Iraq are subject to the damaging effects of very hot dry winds in summer, which sometimes cause severe duststorms and, in certain areas where soils are light and sandy, wind-erosion occurs. The importance and value of windbreak planting throughout the cultivated areas as a means of mitigating wind erosion and damage to crops is recognized as one of the main objects of forestry development.

3. *Production plantations.* Apart from the mountain forests in the northern parts of the country, Iraq boasts of few other natural forest resources and the bulk of its wood requirements has to be imported. Forestry is therefore expected to play an important role in the future through the planting of large areas of short-rotation, irrigated tree crops to supply local needs in commercial and domestic wood.

Iran

• A report to the Near East Forestry Commission describes the natural pastures of Iran which can be divided as follows:

1. The region around the Caspian Sea, where the rainfall is about 400 to 1,700 millimeters, increasing from east to west. It covers an area of 30 million hectares of forest, and 50 million hectares of pasture land comprising:

(*a*) the plain lands that form the winter pastures;
(*b*) sloping lands, most of which are forest lands (most of the spring and autumn pastures are located in these parts);
(*c*) the high lands that are used as summer pastures.

2. The region around the Persian Gulf. This regions is not so usable owing to lack of water and much heat. The climate is dry and the number of cattle is limited.

3. The plateau of Iran — which covers the main part of the country and extends near the Lurestan, Kurdistan and Azerbaijan mountains and the mountains of the east and is divided into two parts:

(*a*) the desert region, in which the amount of rainfall is about 13 to 90 millimeters. Hot winds cause the movement of shifting sands. There are some places where pastures can be created by irrigation, but other parts are not so utilizable.
(*b*) the steppe region, which covers an area of about 70 million hectares, 10 million of which are covered with thinly scattered forests: most of the population of this region is composed of nomadic tribes and most of the pastures are both summer and winter grounds.

INDIA: *A common method of transporting hewn sleepers in the mountains of India. They are carried down considerable distances from the felling sites to roadside depots at lower elevations. The photograph was taken by a member of a team of Finnish foresters who studied the exploitation possibilities of sectors of Himalayan forests, under a bilateral agreement between the governments of India and Finland.*

Courtesy, Kullervo Kuusela

The grazing period on summer pastures and the high lands — which wholly depends on the weather — does not exceed 4 months; the maximum grazing period on winter pastures and plains and at medium altitudes is 7 months.

For the purpose of protecting the forests, a bill has been prepared and presented to Parliament, After its approval, the Forest Service (Bongah Djangalha) will have more power to control the grazing of livestock in the forests and protect the pastures.

Italy

• During the period 1955 to 1957, considerable progress was made with the implementation of the Law relating to the rehabilitation of mountain territories, according to the National FAO Committee. Loans and sub-

sidies were allocated to private owners and agencies for land reclamation work, craftsmanship and tourism. Loans were chiefly granted for land improvement, the creation of industrial processing plants for products of mountain areas, and for the improvement and repair of private buildings which would make them attractive living quarters for tourists. Subsidies were only granted for land and agricultural improvement.

A further 23 mountain reclamation areas, covering a total extension of 1,508,174 hectares, were classified; 22 administrative consortia already in existence were officially appointed as mountain reclamation consortia, and in addition 5 voluntary and 8 official mountain reclamation consortia were also set up.

Funds to a total of about 325.5 million lire (U.S.$522,400) were advanced for the preparation of 44 mountain reclamation projects. About 396 million lire (U.S.$633,500) have been allotted for the study and preparation of economic plans and for research in irrigation and drinking water: 300 million lire (U.S.$480,000) have been assigned to 7 specialized agencies and to similar consortia which are responsible for proper management of forestry and pasture lands belonging to communes. Other technical assistance agencies for agriculture, forestry, and livestock and for assistance to the mountain population have also benefited from this allocation of funds.

Contributions were also made to stimulate production and more rapid improvement in the depressed mountain areas. In fact, although it is important to improve housing facilities for the mountain population, in some cases it would appear more economic to invest in more immediately profitable activities with a view to increasing the farmer's income, postponing any improvements which would give him more comfort, provided they are not of dire necessity. For this reason, a larger portion of the funds has been assigned for the purchase of selected livestock, seeds and fertilizers.

Jordan

• The boundaries of forest lands are marked with cairns, wire fences or iron angles. They are all mapped and indexed. 1,157,237 dunums (11,572 hectares) of land are registered as State Forest Domain of which approximately 1,000,000 dunums (10,000 hectares) are in natural forests, afforested areas or reserved for afforestation.

The 1957 statistical report for Jordan lists the following number of livestock:

Camels:	13,500
Cattle:	64,000
Goats:	541,000
Sheep:	453,500

Of this number, 150,000 goats and 500 sheep are grazed on forest lands on a rotation basis. The village is allotted a block of forest land each year to graze. These blocks are rotated so that no area is grazed two years in succession. During 1958, as an emergency measure to meet the drought conditions in Jordan, all forest areas were being grazed except reforestation areas and coppice forests. Between 750,000 and 1 million animals were expected to receive some grazing in forest lands during this emergency, states an official report to the Near East Forestry Commission. Grazing rights on forest lands belonging to the State are determined by the State. Some villages have certain rights under the Goat Law: if they request permission to convert certain of their grazing lands into forests and they agree to dispose of their goats in return for which they may receive a government loan to buy white sheep, they are given employment as needed on forest land, and the village will receive one third of the receipts from the sale of products from the forested areas.

No effective grassland improvement program of general application has been made. Water-spreading projects in desert areas have not been universally successful and grass seeding work has been restricted to small experimental plots. Fenced enclosures have been set up to demonstrate the results of no grazing but, so far, no managed grazing has been established within the fenced areas to demonstrate what can be expected from proper management.

A cistern program to provide water may have the effect of better distribution of stock over the desert areas but, in actual practice, probably only increases overgrazing throughout a wide area, because of the habit of the bedouin tribes to follow the water supply; thus additional flocks are brought in to graze from far off areas.

The supplementary feeding of fodder is still in the theoretical stage. Two sheep stations, one at Shumari near Azraq, and the other established during 1958 in South Jordan, experiment with the feeding of sheep as well as the production of grasses and grass seed to improve grazing on forest and range areas.

Kenya

• An official report to FAO states that the introduction of controlled grazing over some 380,000 acres (153,500 hectares) of overstocked and eroded land in the Rift Valley and Southern Provinces has been accompanied by a spectacular recovery in the carrying capacity of the land. In Kitui district especially, the face of the country has been entirely changed in five years and the stock population is now at its optimum level for the district as a whole. Bush encroachment remains a problem which will have to be controlled by firing at intervals. Elsewhere in the Southern Province the re-establishment of grass over wide expanses of eroded land has been achieved by scratch plowing and the exclusion of stock for a suitable period.

Libya

• In the Province of Tripolitania, two important events that have been reported to the Near East Forestry Commission are:

1. The passing of a new Forest Law (No. 12) in October 1956. This new forest law enables the Administration to administer its forest estate in an orderly and competent manner and empowers it to enact legislation designed to safeguard and promote the country's timber and fuel resources, both government and privately owned, to the best advantage.

2. The establishment in April 1957 of a Department of Forests under the jurisdiction of the Nazir of Agriculture. This new department is entrusted with the development of a provincial forest estate to meet the province's needs in domestic and industrial timber and forestry products, and to ensure that private forestry gets the encouragement and assistance it needs so that it can be developed on sound forestry and economic principles.

This is the long-term aspect. Of immediate concern is the need to conserve and improve the land by the stabilization of the enormous sand dune areas, to provide protection for agricultural land and to halt and control erosion of the soil by the elements and by man and his animals.

The forestry position in the province at present is perhaps well known. It is a picture of almost complete denudation of indigenous tree growth. The process of denudation has taken place over thousands

of years and the loss of soil consequent upon this must have reached astronomical figures over the period. In more recent times this process has been greatly accelerated due primarily to overgrazing, but also to shifting cultivation and unplanned agriculture as a whole.

In the agricultural field, development has taken place on the coastal plain in recent years through the use of irrigation from comparatively shallow wells, and already there is evidence of salinity and a drop in the water table. Unless this process is replaced by a system of dry farming, the situation may, in time, become desperate. Planned land utilization making full use of trees would appear to be the only solution to the problem. Forestry activity must be dovetailed into planned economic development with the emphasis on agriculture (an economic necéssity), horticulture, controlled grazing, erosion control and the whole range of planned land utilization.

The new Forest Service is designed to work in the closest possible collaboration with other government departments and with development agencies already in the field. The first year's activities have been closely bound with those of other projects and the co-operation experienced is most encouraging.

The provincial (government) forest estate in Tripolitania is scattered in the form of reserves over the length and breadth of the coastal plain and it is often difficult to define where a reserve begins or ends. Boundary disputes are frequent and bitter. Despite its claim to these areas, in law, it is doubtful if the department has in fact any legal title to much of this land. A forest inventory is urgently needed and toward this end, steps are already being taken. Funds to undertake this gigantic task have been made available in the United States Operations Mission forestry development program and the Director of State Property has promised his assistance on the settlement side.

Until an up-to-date inventory has been carried out, development and working plans cannot be made.

Mexico

• A newspaper report describes how the Mexican legislature has called experts to address it in public conclave so that the country's pressing technical problems can be assessed.

The first subject to be thus discussed was the exploitation and conservation of forests. The first spokesman to be called contrasted Mexico's neglect of resources with Sweden's planning. He said that Mexico needed about £6 million (U.S.$ 16.8 million) to pay forest guards and to study and develop the industry. He deprecated any proposal for nationalization for which he considers the State is unprepared.

One tenth of Mexico's population is made up of unintegrated Indians living in forest-covered mountains, which they cannot exploit because they have neither roads, capital, nor adequate technology. "If we do not give the indigenous Indian means to avail himself of the forests, he will destroy them." This would not be because the Indians were ignorant of the problem, but from the sheer necessity of survival. "They fell the woods, burn the trees, uproot the stumps, and then sow. A few kilos of maize are obtained in exchange for acres of valuable trees."

To the outspoken criticisms of the experts the Senate will presumably add the more detailed studies made since 1951 by a mission of FAO forestry experts. Volume Two of the mission's findings has recently been published by the *Departamento de Investagaciones Industriales* of the Bank of Mexico.

Norway

• At the invitation of the Government of Norway, the Joint FAO/ECE Committee on Forest Working Techniques and Training of Forest Workers will hold its third session in Oslo from 1 to 5 June 1959. This Committee, set up in 1954 as a suborgan of the European Forestry Commission and ECE Timber Committee, is concerned with the rationalization of timber extraction and the raising of the productivity of forest work through the improvement of working techniques, tools and machinery.

At this session the Committee, following its usual practice, will review the activities of its sub-organs and draw up its program of work for the next one to two years. This program now covers working techniques, the testing and applications of machinery, mountain logging, vocational training, accident prevention and terminology. The work is carried out by means of specialized working parties and study groups which are responsible for the detailed planning of projects to be entrusted to expert rapporteurs from one or several countries. For example, an important task has been the standardization of tests for forest machinery, as the result of which provisional protocols for the testing of tractors and winches have been drawn up. Similar work is being undertaken on the testing of power saws, barking machines and chipping machines. Other projects include technical, technological and economic studies of tractors, power saws, barking machines, cableways and forest roads.

Work on vocational training and prevention of accidents is carried out in collaboration with the International Labour Office (ILO). International co-operation at the medium and lower levels of forest personnel is assured through the ILO Fellowship Scheme and the joint FAO/ECE/ILO sponsorship of international training courses.

The Oslo session of the Committee will, among other things, discuss ways to concentrate its efforts so as to achieve optimum results with the resources available. This may result in changes in the type of meetings organized and the number and functions of the participants.

The session will be followed by a study tour organized by the Norwegian forest authorities, during which participants will be able to study the most up-to-date aspects of forest exploitation in that country and to visit research institutes and other establishments concerned with the techniques of wood extraction and utilization.

Somaliland (British)

• The first forest officers were appointed to the Somaliland Protectorate in 1952. Before then a few forestry and arboricultural activities had been started by agricultural and veterinary officers. These activities included the establishment of 6 hectares of plantation of *Conocarpus lancifolius* (damas) in a difficult environment at Berbera, the establishment of two small tree nurseries, considerable amenity planting, and some useful preliminary work on *Boswellia carteri* (mohur) and *B. frereana* (maidi), the frankincenses. Three ordinances covering various aspects of forestry were in operation though not completely enforced: 34 square kilometers of forest had been reserved, but boundaries had not been demarcated.

The period 1952-1956 was used to examine the country in detail and to prepare an outline program of work to be done, to obtain sanction for adequate senior and field staff, to start training the field staff, to initiate urgently needed protective measures (e.g., control of charcoal manufacture and propaganda designed to bring about grazing control), to carry out forest reservation as the staff situation permitted, and gener-

TANGANYIKA: *House-building in villages presents no great difficulties. The framework of poles will be daubed with mud. The straw on the ground has been collected during the previous rainy season and is now dry and ready for roofing.*
Courtesy, M. Ganzin

ally to make the people conscious of the meaning of forestry and range management. In 1957, the full requirement of senior staff was appointed, and considerable advance had been made with the recruitment and training of field staff.

There has not yet been formal approval of any forest policy statement. The statement given in outline below is as reported to the Near East Forestry Commission.

Clause 1. The creation of permanent forest resources by the reservation by the Government or by local councils of suitably situated areas of forest or of land to be afforested of an extent sufficient to supply as many benefits as possible for the welfare of the people; indirect benefits in the form of preservation and improvement of water supplies, and maintenance of climatic conditions favorable to the livestock industry and the growth of agricultural crops, and the reduction to a minimum of soil erosion, and direct benefits in the form of a sustained adequate supply of forest produce, including grazing and browse, to meet local requirements and the demands of the export trade.

Clause 2. The broad definition and the public recognition of lands outside the permanent forest estate which are required as permanent rangeland for the livestock industry, whether as grazing or browse, and the creation of facilities for the supervision of these rangelands by local councils or any other agency with or without direct government assistance.

Clause 3. The management of the permanent forest resources and rangeland by methods that will achieve maximum productivity and value on the basis of a sustained yield.

Clause 4. The conduct of research into all branches of scientific forestry and range management, with special early emphasis on ecology, silviculture, and grazing and browse problems.

Clause 5. The development of local and district council forestry and range management; and the education of local councils and people to a better understanding of the necessity for, and the value of, forestry and range management.

Clause 6. The training of Somali to higher posts in forestry and range management, and the provision of adequate training facilities for the field staff.

Clause 7. Co-operation with all other interests in the conservation of soil, water, and vegetation, and in the development of plans for optimum land use.

Sudan

• The Forest Department is running 11 sawmills and 22 hand sawing camps. The production of sawn timber during the last three years is reported to have been as follows:

	Cubic feet	*Cubic meters*
1955-56	405,000	11,500
1956-57	638,000	18,000
1957-58 [1]	790,000	22,400

The main species utilized are *Acacia arabica, Isoberlina doka, Khaya senegalensis, Khaya grandifoliola, Podocarpus melinjainus, Afzelia africana,* and *Danielia oliveri.* The progressive increase in the volume of sawn timber is due to improvements in the sawmills, reduction of waste and improved extraction equipment. Three caterpillar D. 6 tractors and 11 wheeled diesel tractors have been added to the extraction equipment of the Department. Six old extraction lorries have been replaced by new ones.

Five portable saw benches received in 1955 were not found suitable for production of Sudan Railways sleepers but are used successfully for the sawing of smaller sleepers of 4 × 8 × 48 inches (10 × 20 × 122 centimeters) and for other small sizes. Another six portable push benches since obtained have been found to be satisfactory for converting waste wood. A lot of the sawmill machinery which had been recommended in the FAO Technical Assistance Report No. 554 has been received and is in the course of erection, according to an official report to the Near East Forestry Commission. The department is operating a set of three seasoning kilns at Katire in Equatoria. Each has a capacity of 500 cubic feet (14.15 cubic meters). Another one is being built in Khartoum.

The Forest Department supplies the three towns, Khartoum, Wad Medani and Gezira with poles for native buildings. The species used for this purpose are *Acacia arabica,* creosoted *Acacia seyal* and *Anogeisus schemperi.* The last is supplied to Khartoum only. The department has been trying to supply the Post and Telegraph Department with some of its requirements of poles. Poles of *Anogeisus schemperi* and *Isoberlinia doka* have been supplied for trial.

Wood and charcoal are the main sources of fuel in the country. The supply of the three towns Khartoum, Wad Medani and the Gezira is arranged for by the Forest Department, and steps are being taken to arrange also for the supply of Port Sudan. Charcoal production for the three towns is carried out by licenced charcoal burners by special permits from the Forest Department. The quantities produced have been: 1955/56, 22,307 tons; and 1956/57, 25,162 tons.

Charcoal ovens supplied by FAO have been found to be very satisfactory and another 40 similar ones have been made locally for distribution to outstations.

The department also supplies other government departments with their requirements of fuelwood. The amount of firewood produced by the department annually is about 100,000 cubic meters.

In rural areas fuelwood is collected and brought into the towns and big villages by the collectors in head

[1] Estimated.

loads or on donkeys or camels. The amount of wood taken in this way and that used for charcoal is estimated at 13 million cubic meters.

Thailand

• In 1956, a forestry school was established in the province of Phrae, to take 50 students each year for basic training in forestry. Courses last two years, and the purpose is to train junior staffs.

A number of Fellowships have been awarded under the Colombo Plan for study and training in England. In 1957, a senior officer of the Royal Forest Department attended the Tropical Forestry Training Center at Rio Piedras, Puerto Rico, for 3 months.

Through FAO technical assistance and with the completion of the new laboratory at Bangkhen, it has been possible to install one pilot drying kiln, one pilot preservation plant, one small plywood plant, a set of woodworking machines, and two timber strength-testing apparatus. The laboratory is ready to begin some fundamental research work in the field of wood technology.

United Kingdom

• A brochure published by the Ministry of Agriculture, Northern Ireland, describes how the acceleration of afforestation since the end of the 1939-45 war has had a corresponding effect on the size of the permanent labor force, which has increased steadily from its 1946 level of some 260 to its present level of more than 1,500 men.

One of the important factors affecting forestry employment is the availability of suitable housing. As inevitably the forests are situated in the more remote and isolated parts of the country, it has been necessary for the Ministry of Agriculture (Forestry Division) to initiate quite a large-scale housing program of its own. The houses are built sometimes singly or in pairs, sometimes in quite large groups which will in time develop into new forest villages; all are designed to fulfill modern standards of amenity and convenience. About 200 houses have already been built by the Ministry and, in addition, approximately 100 " old " houses, i.e., houses acquired with land and repaired or reconstructed, are occupied by the Ministry's employees. As the forest area grows, many more houses will undoubtedly become necessary.

Training workers up to the rank of foreman in the various branches of forestry is done locally under the supervision of the Ministry's trained foresters and forest officers. The latter are generally trained at universities in Great Britain, while potential foresters are catered for at the schools of the United Kingdom Forestry Commission, since the number requiring training at any one time is not sufficient to justify the establishment of special training schools or a university faculty in Northern Ireland. In the Ministry's service there is a considerable number of young men whose ability has earned them free training as foresters, with allowances while training roughly equivalent to normal pay, who can now look forward to a rewarding career in the forest service.

The same reasons that have made it impracticable to give higher training in forestry in Northern Ireland have resulted also in the restriction of forest research to problems of local rather than fundamental significance. Fundamental research demands the large-scale resources which are associated with the Forestry Commission and universities of Great Britain, the fruits of whose investigations are generally both relevant and available to Northern Ireland. The Ministry, for its part, co-operates wherever possible in carrying out complementary experiments.

One problem requiring more extensive research than was being given to it by the Forestry Commission, was that of tree-planting on peat areas. Accordingly, in co-operation with the Ministry's Research Division and Queen's University, Belfast, a series of experiments have been laid down. It is hoped that information derived from these experiments will eventually prove a valuable guide to improvement of peat-land afforestation technique. The importance of the experiments may be judged from an estimate that every 100 feet (30 meters) above the normal planting altitude of around 1,200 feet (365 meters) which can be planted, represents rather more than 5,000 acres (2,000 hectares) of new area gained.

• Perhaps the most significant single event in forestry in recent years was the completion late in 1957 of the nation-wide *Timber Resource Review*, begun in 1952. This most comprehensive appraisal of the timber situation in the United States yet undertaken is the latest in a series of such appraisals. It was planned and executed in the field with the widespread collaboration of a great number of states, forest industries, and individuals. It provides a stock-taking of the current timber situation and a look into the future with respect to prospective timber supplies and needs. The *Review* points out that much progress has been made in forestry in the United States in recent years, particularly on large industrial holdings and public lands. No timber famine is in the offing, but some shortages may be expected in preferred species and grades, especially after 1975. It is estimated that, by the year 2,000, the much larger population will require nearly twice the present production of wood to meet its needs. Substantial expansion and intensification of forestry will be required to assure such a level of production.

The *Review* found that the key to the future timber supply lies in a large measure with the 4.5 million owners of small timber tracts who collectively own over one half of the country's timber lands and who have been the least progressive in forestry. Consequently, renewed and increased efforts are called for in developing ways and means of encouraging wider application of good forestry practices on the small holdings.

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